

SUPPORTING INFORMATION

Pollutant Emissions and Energy Efficiency under Controlled Conditions for Household Biomass Cookstoves and Implications for Metrics Useful in Setting International Test Standards

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1. Background Information - PCIA

The PCIA (Partnership for Clean Indoor Air), supported by the USEPA (United States Environmental Protection Agency), was initiated in 2002, and the worldwide organization grew to more than 500 partners involved in all aspects of improving cookstoves for the developing world. In addition to many other activities, PCIA/USEPA sponsored testing of cookstoves under controlled and field conditions. Jetter and Kariher¹ published results of a previous round of cookstove tests under controlled conditions. MacCarty et al.² published results from numerous controlled tests, many of which were supported by USEPA, and Johnson et al.³ recently conducted field evaluations supported by USEPA. A second round of cookstove testing under controlled conditions, reported in this article, was conducted from May to October 2010, and was also supported by PCIA/USEPA. PCIA is now integrated with the Global Alliance for Clean Cookstoves.

2. Cookstoves

The 22 cookstoves that were tested are shown in Figure SI-1. Stove selection was not based on formal criteria, but consideration was given to availability, quantity disseminated, previous test results, innovation, and interest from PCIA partners. Due to cost/logistics constraints, this work could include only one example of a non-portable, built-in-place, improved stove (the Onil stove). Many improved stove programs in the past and present promote built-in-place stoves, and in the future, more of these stoves will be evaluated.

Stoves were arranged in Figure SI-1 in a random fashion, and stove descriptions below are listed in the same order as in Table 1 in the Research Article. Information on the number of stoves disseminated and on cost is included, if that information was reported by the manufacturer, but this information was not verified, and it may be outdated.

A. 3-Stone Fire. The 3-stone fire is the most commonly used traditional method of cooking. Two variations of the 3-stone fire were tested as baseline cases. In the “carefully tended” mode, fuelwood sticks were arranged in a radial pattern with the fire at the center, and sticks were continually fed into the center so that the ends of the sticks consistently burned. In the “minimally tended” mode, fuelwood was loaded in batches approximately every 10 minutes, and the 3-stone cookfire was not tended between fuel loadings. The minimally tended 3-stone fire was considered to be more representative of use of 3-stone fires in the field.

B. Berkeley-Darfur Stove. Ashok Gadgil, Lawrence Berkeley National Laboratory, initiated the development of this stove that is disseminated by the Darfur Stoves Project⁴. The design was adapted from the Tara Stove, originally made in India. The Berkeley-Darfur stove has a cast iron grate, and other components are made from sheet metal and are efficiently shipped flat to Darfur where they are assembled into stoves. Approximately 9,000 stoves were reportedly disseminated in 2010. The stove was tested with a round-bottomed cast aluminum pot, as shown in Figure SI-1, that the stove was designed for. Production cost for the stove was reported to be approximately US\$25, and the stoves have been disseminated free of cost in Darfur.



Figure SI-2. Cookstoves tested. A. 3-Stone Fire; B. Berkeley-Darfur Stove; C. Envirofit G-3300 Stove; D. Onil (HELPS International) Stove; E. Philips Natural Draft Stove HD4008; F. Philips Power Stove HD4012; G. Sampada Gasifier Stove; H. StoveTec Greenfire Wood Stove; I. Upesi Portable Stove; J. GERES NLS (New Lao Stove); K. Gyapa Stove; L. Jiko, Ceramic; M. Jiko, Metal; N. KCJ (Kenya Ceramic Jiko) Standard Stove; O. Kenya Uhai Stove; P. StoveTec Prototype Charcoal Stove; Q. Belonio Rice Husk Gas Stove; R. Mayon Turbo Stove 7000; S. Oorja Stove; T. StoveTec Prototype TLUD Stove; U. Jinqilin CKQ-80I Stove; V. Protos Stove

C. Envirofit G-3300 Stove. This mass-produced stove was initially developed by Colorado State University and is disseminated by Envirofit International. At the time of the testing, approximately 15,000 stoves had been disseminated in seven months, according to the manufacturer. The stove has a rocket combustion chamber made of high-temperature alloy steel. A removable grate is made of cast iron. The stove was tested with an Envirofit G-33SKT pot skirt accessory. An instructional video on a CD (compact disk) was provided with the stove. Retail cost for the stove was reported to be approximately US\$31, not including the pot skirt accessory.

D. Onil (HELPS International) Stove. Don O’Neal, HELPS International engineer/volunteer, initially developed this stove to reduce serious burns, especially to children, caused by traditional stoves and open cooking fires. The stove has a metal chimney and a rocket combustion chamber made of ceramic

material. The stove body is made of pre-cast concrete parts, and the stove is assembled on site. A flat, steel top, called a plancha, is useful for making tortillas and for frying foods. The plancha has removable steel rings to enable the bottom of a cooking pot to be directly exposed to hot combustion gases. The stove was tested with a chimney that was approximately 2 m in height.

E. Philips Natural Draft Stove HD4008. This stove is disseminated by Philips Electronics India Ltd. The stove was designed to use wood and other biomass fuels. Natural draft (convection) provides air flow for combustion. The base of the stove is made of coated steel, the upper body is made of galvanized steel, and the combustion chamber and top are made of steel. An operation manual was provided with the stove. Retail cost was reported to be approximately US\$31.

F. Philips Power Stove HD4012. This stove is disseminated by Philips Electronics India Ltd. The stove was designed to use wood and other biomass fuels. A rechargeable battery and fan provide forced-draft air to the combustion chamber. Whereas the previously tested¹ Philips HD4010 was self-powered (a thermoelectric device used heat from the stove to recharge the battery and power the fan), the HD4012 requires a source of electricity to recharge the battery and/or power the fan. The base of the stove is injection-molded plastic, the upper body is made of stainless steel, and the combustion chamber is made of thin ceramic tiles. An operation manual was provided with the stove. Retail cost was reported to be approximately US\$89.

G. Sampada Gasifier Stove. This stove was developed by ARTI (Appropriate Rural Technology Institute) and is distributed by Samuchit Enviro-Tech Private Limited in India. The stove is designed to burn wood or other biomass and to produce charcoal. The outer body of the stove is stainless steel, and the inner parts are steel. An instruction sheet and instructional video on CD were provided with the stove. Retail cost for the stove was reported to be approximately US\$38.

H. StoveTec Greenfire Wood Stove. This mass-produced stove was developed by Aprovecho Research Center and is disseminated by StoveTec/EcoZoom. The stove has a rocket combustion chamber made of ceramic material, and the top of the stove is made of cast iron. A pot skirt was provided with the stove. Operating instructions were printed on the carton containing the stove, and a user's manual was available online. StoveTec reported that approximately 35,000 stoves, including all other models, have been disseminated per year. Wholesale cost for the model that was tested was reported to be approximately US\$9 in quantities of approximately 3,000.

I. Upesi Portable Stove. This metal-clad, ceramic, wood-burning stove has been disseminated in Africa by the organization, Practical Action, in reported quantities of approximately 30,000 per year. Retail cost was reported to be approximately US\$9.50.

J. GERES NLS (New Lao Stove). This metal-clad ceramic stove was developed by GERES (Groupe Energies Renouvelables, Environnement et Solidarités - a French non-profit NGO) and has been disseminated in large reported quantities (>250,000/yr) in Cambodia. The stove is primarily used with charcoal fuel, but it is designed to also use woodfuel. A ceramic piece between the fuel grate and pot is removable for adding fuel during operation of the stove. In this study, the stove was tested with charcoal fuel. Retail cost was reported to be approximately US\$3.50.

K. Gyapa Stove. This metal-clad, ceramic, charcoal stove is made in Ghana by small-scale metal workers and ceramicists, and it has been disseminated by Enterprise Works in Ghana. An instruction sheet was provided with the stove.

L. Jiko, Ceramic. “Jiko” means stove in Swahili. This is a typical small metal-clad ceramic charcoal stove with variations used in many countries in Africa. A ceramic grate for holding the charcoal fuel is considered an improvement over the common metal charcoal stove. A ceramic jiko will typically last longer than a metal jiko.

M. Jiko, Metal. This is a typical common small metal charcoal stove with variations used in many countries in Africa and around the world.

N. KCJ (Kenya Ceramic Jiko) Standard Stove. This metal-clad, ceramic, charcoal stove has reportedly been disseminated in large quantities (~500,000/yr) in Africa by the organization, Practical Action. Retail cost was reported to be approximately US\$6.

O. Kenya Uhai Stove. This metal-clad ceramic charcoal stove has been disseminated in Africa by Practical Action in reported quantities of approximately 1,000 per year. It is different from other ceramic-lined charcoal stoves that were tested because the cooking pot rests directly on the ceramic liner, rather than on metal pot rests, and because the ceramic liner has a lip that reduces the size of the opening on top. Retail cost was reported to be approximately US\$11.

P. StoveTec Prototype Charcoal Stove. This prototype metal-clad ceramic stove was adapted from a StoveTec Wood/Charcoal Stove. The stove was provided with a special cooking pot, called a “superpot” with an integral skirt and fins on the bottom for improved heat transfer. In the center of the fuel chamber was a vertical hollow cylindrical core made of perforated metal to provide air flow to the burning charcoal.

Q. Belonio Rice Husk Gas Stove. Alexis Belonio, Central Philippine University, designed this stove to burn waste rice husks that are abundantly available in many rice-growing regions of the world. The stove is a batch-loaded TLUD (top-lit, up-draft) design, and it has an AC (alternating current)-powered fan to provide forced draft. A detailed, operation manual was provided with the stove. Retail cost was reported to be approximately US\$40.

R. Mayon Turbo Stove 7000. This stove was developed by REAP (Resource Efficient Agricultural Production) Canada to burn rice hulls and other crop residues. Fuel is loaded into a hopper, and continuous feeding is possible (unlike other stoves that burn rice hulls with batch loading). The stove is made of steel. Approximately 500 stoves per year reportedly have been disseminated in The Philippines and The Gambia. Retail cost was reported to be approximately US\$15.

S. Oorja Stove. This stove was initially developed by BP (British Petroleum) and was further developed and is now being disseminated by First Energy Private Limited in India. Mukunda et al.⁵ reported on the development of this stove. Biomass pellets made from agriculture residues are used as fuel. A small electrical fan powered by a rechargeable battery provides forced draft. A fan speed controller has a switch with a low and a high position. The combustion chamber is made of ceramic material clad with metal on the outside, and a heat shield is made of stainless steel. An operation manual and an extra

rechargeable battery were provided with the stove. Over 400,000 stoves reportedly have been disseminated in India.

T. StoveTec Prototype TLUD Stove. This prototype stove was adapted from a StoveTec Wood-Charcoal Stove. The stove is a batch-loaded TLUD design, and the fuel is wood pellets. Natural draft (convection) provides air flow for combustion. A pot skirt was provided with the stove.

U. Jinqilin CKQ-80I Stove. This stove was developed by the Linhong Company in China and is manufactured by Shanzi Jinqilin Energy Technology Co., Ltd. Approximately 6,000 stoves per year have reportedly been disseminated in China. Corn cobs are primarily used as fuel, but straw briquettes and wood may also be used. The stove is a gasifier⁶ design with separate controls for primary and secondary air. A hand-operated shuttle mechanism is used for continuous feeding of fuel. The stove has a chimney and an AC-powered fan that provides forced draft. The stove was tested with a chimney that was approximately 2 m in height. The top of the stove has removable, cast-iron rings to enable the bottom of a cooking pot to be directly exposed to hot combustion gases. Retail cost was reported to be approximately US\$100.

V. Protos Stove. This stove was developed by BSH Bosch und Siemens Hausgeräte GmbH, Germany, to use plant oil as fuel. A fuel tank is pressurized with an air pump to deliver fuel to an oil burner. Approximately 500 stoves per year have reportedly been disseminated. Provided with the stove were an operation manual, DVD, a “simmer plate” that can be placed between the burner and pot to reduce cooking power, and tools for cleaning the burner assembly. Production cost was reported to be approximately US\$50.

3. Fuels

Fuels were selected to be similar to typical fuels used in the field for the stoves tested in this study. Fuel moisture content values were also selected to be similar to typical fuel moisture content found in the field. Fuel moisture content values were different for various fuels, because different values are typically found in the field. For example, the moisture content of charcoal fuel is typically lower in the field than the moisture content of woodfuel. All fuel moisture content values discussed below are in percentage on a wet basis. Fuels are shown in Figure SI-2 and are described below.

A. Wood fuel. Red Oak (*Quercus rubra*), a common hardwood, was used for testing wood fueled stoves. One large freshly cut “green” log was obtained from a local supplier, and the log was saw-cut to the desired size (1.5 x 1.5 cm in cross-section, after drying). Fuelwood was cut into lengths of approximately 36 cm for the 3-stone fire and for most of the stoves tested, except shorter lengths of approximately 10 cm were required for the two Philips stoves, and lengths of approximately 20 cm were required for the Sampada stove. Wood was air dried until it reached the desired moisture content (30% on a wet basis) for high-moisture content fuel, hereafter called “wet” fuel. Then half the wood was packed into air-tight drums and stored in a freezer to prevent mold from growing on the wood while maintaining the high moisture content. The other half of the wood was air dried until it reached equilibrium (approximately 10% on a wet basis) for low-moisture content fuel, hereafter called “dry” fuel. High-moisture wood was removed from the freezer, as needed, and thawed to ambient temperature (inside a sealed plastic bag) before using it for testing stoves. This method is recommended for preparing

uniform fuelwood with controlled moisture content. A larger size (2 x 2 cm in cross-section, after drying) may be used for future testing, because it may be more representative of wood commonly used in the field.



Figure SI-2. Fuels tested. A. Wood, B. Charcoal, C. Charcoal igniting material, D. Douglas fir wood pellets, E. Oorja biomass pellets, F. Corn cobs, G. Rice hulls, H. Plant oil

B. Charcoal fuel. Lump charcoal, rather than compressed briquettes, was used, because lump charcoal is typically used in the field. Lump charcoal used in this study was made in Mexico from cord wood (not from lumbar scraps) and was obtained from a local commercial supplier. Dry charcoal, as received from the supplier, had an average moisture content of approximately 5%. Charcoal fuel with higher moisture content was produced by placing the dry charcoal in a humidification chamber at nearly 100% RH (relative humidity) for at least 48 hours to reach an average moisture content of approximately 8%. The charcoal was non-uniform in size and shape, but charcoal with a minimum dimension of approximately 1 cm and a maximum dimension of approximately 6 cm was used for testing. In the future, charcoal may be screened for better uniformity, and charcoal may be sprinkled with water to obtain a higher moisture content.

C. Charcoal igniting material. In the field, charcoal fuel is ignited with many different materials. In this study, charcoal was ignited with a solid material, commercially available for the purpose of igniting charcoal, made from 90% wood fiber and 10% recycled newsprint, wood waste and paraffin wax. All charcoal was ignited with approximately 45 g of this material, except charcoal fuel for the StoveTec charcoal stove was ignited with charcoal lighter fluid, as recommended by the manufacturer.

D-E. Pellet fuel. The StoveTec prototype TLUD stove was tested with Douglas fir wood pellets (Figure SI-2. D) obtained from a commercial supplier in Oregon, U.S., and the Oorja stove was tested with Oorja

biomass pellets (Figure SI-2. E) provided by the manufacturer in India. As received, the Douglas fir wood pellets had a moisture content of approximately 4%, and the Oorja pellets had a moisture content of approximately 9%. Higher moisture content fuel was produced by sprinkling pellets with water and sealing in an air-tight container for at least 24 hours to obtain the desired moisture content (14%).

F. Corn cob fuel. Dry corn cob fuel was obtained from a commercial supplier in the U.S. As received, the corn cob fuel had a moisture content of approximately 9%. Fuel with higher moisture content was produced by sprinkling cobs with water and sealing in an air-tight container for at least 24 hours to obtain the desired moisture content (30% on a wet basis).

G. Rice hull fuel. Dry rice hull fuel obtained from a commercial supplier in the U.S. had a moisture content of approximately 11%, and fuel with higher moisture content was produced by sprinkling rice hulls with water and sealing in an air-tight container for at least 24 hours to obtain the desired moisture content (18%). Rice hulls did not readily absorb water, and vigorous mixing of the fuel and water was required to obtain the desired moisture content.

H. Plant oil fuel. The Protos stove was designed to burn various plant oils. In this study, rapeseed (canola) oil was obtained from a local store, as recommended by the manufacturer.

4. Cooking Pots

Standard 5-liter cooking pot. This cooking pot has frequently been used as the standard pot for the WBT (water boiling test) protocol⁷ by other stove testers, such as Aprovecho Research Center, Cottage Grove, Oregon. This flat-bottomed pot has a weight of approximately 815 grams. Full capacity is approximately 7.5 liters, and the pot is used with 5 liters of water for the WBT. Material is stainless steel. Thickness is approximately 0.5 mm. Outside diameter of the rolled edge at the top of the pot is 257 mm, and inside diameter of the pot at the top is 244 mm. Outside diameter at the bottom is 243 mm. Height (not including handles) is 162 mm. The radius of the curve at the bottom edge is approximately 5 mm. Handles are made of 7 mm diameter stainless steel rod. The pot was obtained from the Danish CICCI company that provides supplies for emergency relief and development projects around the world. The pot is shown in Figure SI-1, labeled A.

Standard 2-liter cooking pot. This cooking pot has also been frequently used as the standard pot for the WBT protocol by other stove testers, such as Aprovecho Research Center, for testing stoves that do not have enough power to consistently boil 5 liters of water. This flat-bottomed pot has a weight of approximately 553 grams. Full capacity is approximately 3 liters, and the pot was used with 2 liters of water for this study. Material is stainless steel. Thickness is approximately 0.5 mm. Outside diameter of the rolled edge at the top of the pot is 216 mm, and inside diameter near the top of the pot is 200 mm. Outside diameter at the bottom is 196 mm. Height (not including handles) is 98 mm. The radius of the curve at the bottom edge is approximately 19 mm. Handles are made of 7 mm diameter stainless steel rod. This pot was also obtained from the Danish CICCI company.

Round-bottomed cast-aluminum 5-liter cooking pot. This cooking pot was used for testing stoves designed for round-bottomed pots. The weight of the cast aluminum pot is approximately 1900 grams. Full capacity is approximately 9.8 liters, and the pot was used with 5 liters of water for the WBT.

Thickness is approximately 4 mm. Maximum inside diameter is approximately 280 mm. Height is approximately 200 mm. This pot was made in Africa and was obtained from the Berkeley-Darfur stove team. The pot is shown in Figure SI-1, with the stove labeled B.

“Superpot” 5-liter cooking pot. This cooking pot was used with only the StoveTec prototype charcoal stove in this study. This pot has an integral skirt and fins on the bottom for improved heat transfer. This flat-bottomed pot has a weight of 1440 grams. Full capacity is approximately 6.8 liters, and the pot was used with 5 liters of water for the WBT. Material is steel. Thickness is approximately 0.5 mm. Outside diameter of the lip at the top of the pot is 285 mm, and inside diameter near the top of the pot is 235 mm. Outside diameter at the bottom is 235 mm. External height is 203 mm and internal height is 158 mm. The radius of the curve at the bottom edge is approximately 7 mm. Handles are made of 5 mm diameter steel rod. This pot was obtained from Aprovecho Research Center. The pot is shown in Figure SI-1, with the stove labeled P.

5. Emissions Testing Facility

The emissions test system, shown in Figure SI-3, consisted of a hood for collecting emissions from the stoves, a HEPA filter for removing particles from dilution air, an air duct (dilution tunnel) for sampling air pollutants, and a blower for drawing air through the hood, HEPA filter, and duct. Air flow was adjusted so that all emissions were collected by the hood, but the velocity of air currents near the stove was less than 0.25 m s^{-1} to minimize the effect on performance of the stove. Air velocity near the stove was measured with a hot-wire anemometer, TSI Model 8450 (Saint Paul, Minnesota). Air velocity in the duct was measured with a pitot tube array, Ultratech AMS (Garner, NC), and air mass flow was determined by measurements of air velocity, temperature, and pressure. The Hildemann⁸ dilution sampling system was used to obtain lower concentrations of pollutants needed for the instruments listed in the figure. Stoves with chimneys were tested with the top end of the chimney inside the hood, and thus both the chimney emissions and fugitive emissions from the stove itself were captured.

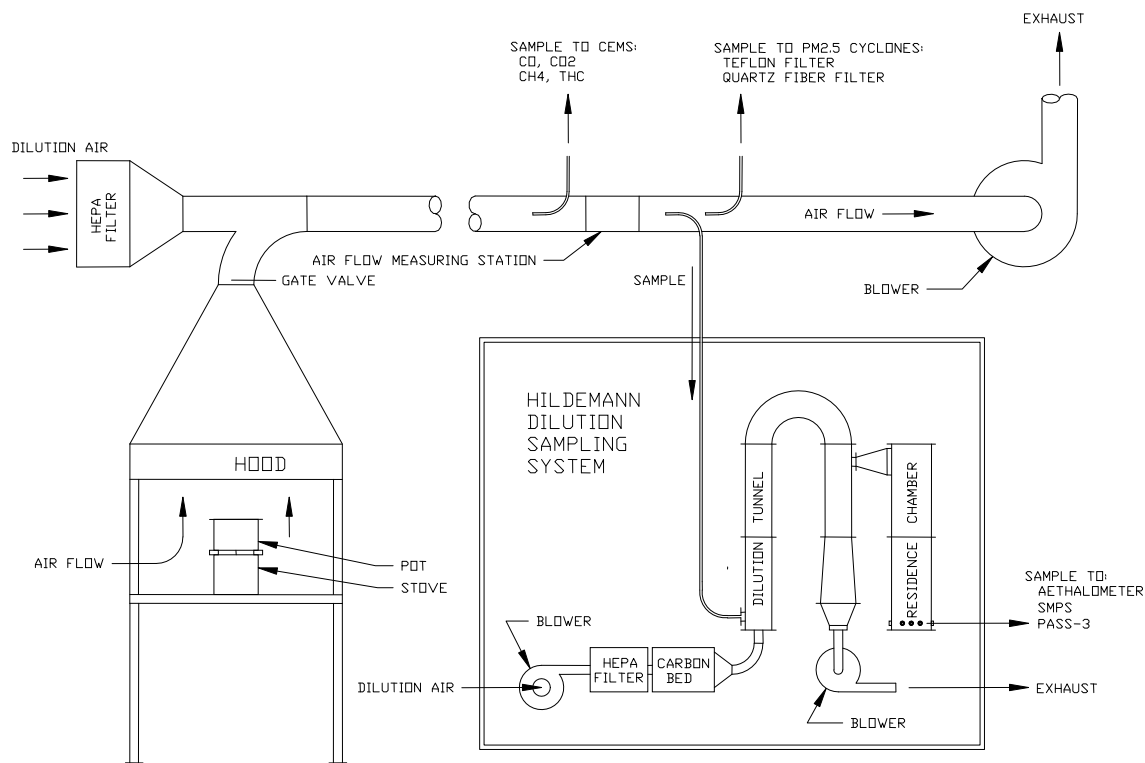


Figure SI-3. Test system diagram

6. Test Protocol Modified for Charcoal Stoves

A modified procedure was used for charcoal stoves, similar to the procedure used in previous testing¹, because charcoal fuel takes longer to ignite than other fuels. Charcoal stoves typically produce a large amount of smoke during a cold start. For this reason, stoves are typically started outdoors and are brought indoors after the charcoal is hot and stops smoking. Although the hot charcoal produces little visible smoke, it typically produces a large amount of CO, so charcoal stoves should be used only in very well ventilated areas. For each cold start, 45 g of the solid charcoal igniting material (described above) was arranged in a triangular shape recommended by the manufacturer of the material, and charcoal was placed around the material. The cooking pot was placed on the stove after the charcoal was ignited and the igniting material stopped flaming. During the cold start, relatively high emissions of PM_{2.5} resulted from the ignition process. For the hot start phase of the WBT, the hot charcoal remaining from the cold start phase was weighed, and the hot charcoal was left in place in the stove. Charcoal was added if needed during the hot start phase. Emissions measured during the hot start phase included the relatively low PM_{2.5} emissions and relatively high CO emissions.

7. Emissions and Fuel Use Database Description

Results are reported in an Emissions and Fuel Use Database (see Appendix), as described and referenced in the article. Figures in the database are identified by the letter S and are abbreviated in brackets below, for example Figure S2 is abbreviated [S2]. Results are reported as average values for the test replications, as specified in the WBT protocol, and error bars in the figures represent plus or minus one standard deviation. Each figure in the database is accompanied by the tabulated data.

7.1 Cookstove systems tested. In Table S1 in the database, the 44 cookstove systems tested are listed. Cookstove systems were defined by the cookstove, fuel, moisture content of fuel, cooking pot, chimney (if equipped), pot skirt (if available), and operating procedure.

7.2 Fuel moisture. Fuel moisture content for wood is shown in [S2], for charcoal in [S3-S4], and for other fuels in [S5]. Fuel moisture content was measured on each day the fuel was used for testing. Various amounts of low-moisture (dry) fuel were required for starting and maintaining combustion in stoves tested with high-moisture (wet) fuel. Fuel moisture content is reported as the average (on a mass basis) of wet and dry fuels used for each stove/fuel combination tested. For example, the target moisture content for wet woodfuel was 30%, but the average values shown in [S2] are somewhat lower, because of the additional dry fuel required to perform the tests. Hot charcoal remaining after the cold start (and used during the hot start and simmer) was assumed to have zero moisture content. Moisture content is discussed for each fuel in the Fuels section, above.

7.3 Fuel energy content. Heat of combustion HHV (higher heating values) shown in [S6] were obtained from calorimeter tests, as discussed in the article. LHV (lower heating values), used for the WBT protocol, were estimated from the measured HHV values as follows.

From the WBT protocol⁷:

“LHV – Lower heating value (also called net heating value). This is the theoretical maximum amount of energy that can be extracted from the combustion of the moisture-free fuel if it is completely combusted and the combustion products are cooled to room temperature but the water produced by the reaction of the fuel-bound hydrogen remains in the gas phase. For woodfuels, LHV typically differs from HHV by 1.32 MJ/kg.... Dry wood typically consists of 6% hydrogen by mass. Thus, one kg of dry wood contains 60 g of hydrogen, which reacts to form 540 g of H₂O. The difference in enthalpy between the liquid and gaseous phases of 540 g of water at room temperature is roughly 1.32 MJ, thus, for a typical sample of moisture-free wood, HHV and LHV differ by 1.32 MJ.”

Hydrogen content by mass for other biomass fuels is similar to that for wood (approximately 6%^{9, 10}) so the same difference between HHV and LHV, 1.32 MJ kg⁻¹, was used for rice hulls, biomass pellets, and corn cob fuels. Measured hydrogen content obtained by elemental (ultimate) analysis of fuel samples would provide better accuracy.

Charcoal typically consists of approximately 3.5% hydrogen by mass¹¹, and the difference between HHV and LHV is approximately 0.76 MJ kg⁻¹.

Canola oil varies in chemical composition¹², so the hydrogen content may vary, but an elemental analysis found in the literature¹³ yielded a hydrogen content of 11.84% by mass, and the difference between HHV and LHV was estimated to be approximately 2.6 MJ kg⁻¹.

7.4 Power and time-to-boil. Fire power [S7] is the fuel energy used by the stove per time. Cooking power [S8] is the useful energy delivered to the cooking pot per time. Cooking power is shown in the figure for the cold start and hot start, but not for the simmer, because cooking power cannot be accurately measured during the simmer phase of the WBT, as discussed in the article. Time-to-boil, as defined by the WBT, is shown in [S9-S10]. Cooking power is correlated with time-to-boil, as shown in [S11], and as discussed in the article.

7.5 Efficiency. OTE (overall thermal efficiency) [S12] is the ratio of useful energy (delivered to the cooking pot) to total net energy (in the fuel). OTE is shown in the figure for the cold start and hot start, but not for the simmer, because the useful energy delivered to the cooking pot cannot be accurately measured during the simmer phase of the WBT, as discussed in the article. Compared to the 3-stone fire, most of the stoves tested had better thermal efficiency. MCE (modified combustion efficiency), $\text{CO}_2/(\text{CO}_2+\text{CO})$ as carbon, [S13] is a proxy for combustion efficiency. Compared to the 3-stone fire, some of the stoves had better MCE, although most of the charcoal stoves had worse MCE.

7.6 Fuel use. Fuel burning rates are shown in [S14-S16]. Specific fuel consumption, as shown in [S17-S19], is defined by the WBT as the mass of fuel used per liter of water remaining in the pot at the end of the test. If a stove has a long time-to-boil, then less water remains in the pot at the end of the test (due to loss from steam), and specific fuel consumption tends to be higher. Similarly, if a stove cannot be controlled during the low-power simmer phase to maintain the water at the target temperature below the boiling point, then less water remains at the end of the test, and specific fuel consumption tends to be higher. Specific energy consumption [S20] is similarly affected by the water remaining in the pot at the end of the test.

7.7 Air pollutant emissions. Data are reported for air pollutants [S21-S68] as emission rates per time and as emission factors based on fuel energy, cooking energy, fuel mass, and WBT cooking tasks (cold start, hot start, simmer). Emissions per fuel mass are reported on an equivalent dry basis, as defined by the WBT. Pollutant emissions are reported in terms of mass, except UFP (ultra-fine particles – particles less than 100 nm) emissions are reported in terms of number of particles. The smallest UFP particle size measured was 14.6 nm. Emissions are reported for CO [S21-S28], $\text{PM}_{2.5}$ [S29-36], CO_2 [S37-S44], THC [S45-S52], CH_4 [S53-S60], and UFP [S61-S68].

$\text{PM}_{2.5}$ and CO are frequently used as indicators for emissions from cookstoves. $\text{PM}_{2.5}$ emission rates for household cookstoves are shown in [S29]. Compared with the 3-stone fire, most of the stoves tested had lower emissions of $\text{PM}_{2.5}$, although there were exceptions, as discussed below. For comparison, the USEPA limit for PM emissions from heating stoves is 7.5 g hour^{-1} , but heating stoves generally have greater power than household cookstoves, and heating stoves in the U.S. are always vented with a chimney. Nevertheless, some cookstoves exceeded the limit, as shown in [S29]. Compared with the 3-stone fire, charcoal stoves generally had relatively low emissions of $\text{PM}_{2.5}$, but high emissions of CO [S21].

8. Results and Discussion for Each Stove

A. 3-Stone Fire. For this study, the distance between the testing surface (floor) and the cooking pot was 19 cm, while in a previous study¹, the distance was 9 cm. A greater distance was used for this study, similar to MacCarty et al.¹⁴, because a greater distance was hypothesized to reduce emissions of air pollutants by providing more space for mixing of combustion gases and by reducing the quenching of flames on the cooking pot. Compared with the previous results for the carefully-tended fire with dry fuel, the combustion efficiency [S13] was higher, as expected, and PM_{2.5} emissions [S35] were lower, but the time-to-boil [S9] was longer, thermal efficiency [S12] was lower, and specific fuel consumption [S17] was higher. The greater distance between floor and cooking pot resulted in improved combustion efficiency at the expense of heat transfer efficiency. Compared with the carefully tended 3-stone fire with dry fuel, the 3-stone fires with minimal tending and with wet fuel had higher emissions of air pollutants, as expected. PM_{2.5} emissions [S29] were particularly high with wet fuel. It was not possible to test with wet fuel with minimal tending, because the 3-stone fire required constant tending to maintain combustion with wet fuel. Several previous studies¹⁵⁻¹⁸ found MCE measured in the laboratory to be 96-97%, while a recent field study¹⁹ found MCE to be 93%. This discrepancy is important, because a small difference in combustion efficiency makes a large difference in pollutant emissions. In this study, combustion efficiency [S13] was as low as 93.5% for the 3-stone fire tested under conditions that may be more typical of field use. Future testing of the 3-stone fire may include variation of the distance between the floor and pot, and the inclusion of smoldering combustion based on activity data from the field.

B. Berkeley-Darfur Stove. Compared with the 3-stone fire, maximum cooking power [S8] was similar, thermal efficiency [S12] was much better, and fuel consumption [S17] was much lower. Compared with the 3-stone fire, pollutant emissions per WBT task [S27, 35, 43, 51, 59, 67] were lower. Compared to the Envirofit and StoveTec rocket stoves operated at a medium power level (see below), the Berkeley-Darfur stove had a similar cooking power and had similar pollutant emissions. However, the two rocket stoves had somewhat lower pollutant emissions with wet fuel.

C. Envirofit G-3300 Stove. Compared with the 3-stone fire, maximum cooking power [S8] was higher and time-to-boil [S9] was faster; however, the manufacturer recommended that this stove be operated at a lower cooking power for reduced emissions. The Envirofit G-3300 was tested at maximum power and also at a medium power level (denoted by “med. pwr.” in the database). Four woodfuel sticks were used for maximum power, and three sticks were used for medium power. The medium power level for the Envirofit stove was similar to the maximum cooking power [S8] for the 3-stone fire. Compared with the 3-stone fire, thermal efficiency [S12] was much better and fuel consumption [S17] was much lower at all power levels. Pollutant emissions per WBT task [S27, 35, 43, 51, 59, 67] were lower at all power levels. Pollutant emissions were lower at the medium power level than at maximum power, as expected. Compared with the 3-stone fire, the Envirofit stove had much lower emissions, especially with wet fuel. Results were consistent with Yuntanwi et al.²⁰, who found that, compared with a 3-stone fire, a rocket stove was less susceptible to higher emissions with increased moisture content of fuel. Another rocket stove, the StoveTec Greenfire, was also tested at a medium power level, and the performance was similar for the two stoves. The Envirofit G-33SKT pot skirt, shown in Figure SI-1, was designed to adjust to fit pots of various sizes (similar to the design of certain vegetable steamers), but the adjustable, overlapping leaves easily became mispositioned causing difficulty in placing the cooking pot into the skirt.

D. Onil (HELPS International) Stove. This stove was assembled on site by a representative from HELPS International. The same red oak fuel used for testing other stoves was used for testing this stove, except the wood was split, rather than sawed, as requested by the HELPS representative. Maximum cross-section dimension of the split wood was 4 cm. During the hot start, cooking power [S8] was sufficient to boil 5 liters of water in 34.5 minutes, but during the cold start, the time-to-boil [S9] was 51.0 minutes. Combustion efficiency [S13] was quite good compared to other stoves tested, but thermal efficiency [S12] was low. The slow time-to-boil and the low thermal efficiency were caused by the relatively large thermal mass of the plancha and ceramic combustion chamber. Thermal efficiency was better for the Onil stove than for another plancha stove that was previously tested¹, likely because the removable rings in the Onil plancha provided improved heat transfer to the pot. Compared with other wood-fueled stoves that were tested, fuel consumption [S17] was high, because of the low thermal efficiency. Compared with the 3-stone fire, emissions of CO [S27], THC [S51], and CH₄ [S9] were substantially lower, but emissions of PM_{2.5} [S35] were similar. Tests were attempted for the Onil stove with wet fuel, but time-to-boil for 5 liters of water was greater than 60 minutes, causing inconsistent results. The stove may be tested in the future with a smaller pot. A notable advantage of the Onil stove is the chimney that reduces indoor air pollution. Plancha stoves have other advantages not captured by the WBT, such as the ability to cook tortillas, fry foods, heat multiple pots, and heat the indoor living space; however, the plancha stoves are generally not well suited for boiling water. Development of an appropriate, controlled-test protocol for plancha stoves is needed.

E. Philips Natural Draft Stove HD4008. This stove was operated at a higher fuel burning rate [S14] with wet fuel than with dry fuel to maintain combustion. For this reason, cooking power [S8] was higher and time-to-boil [S9] was faster with wet fuel. Compared with the 3-stone fire, thermal efficiency [S12] was more than twice as high, fuel consumption [S17] was much lower, and CO emissions [S27] were lower. PM_{2.5} emissions [S35] for the HD4008 and the 3-stone fire were similar with dry fuel, but the HD4008 had much lower emissions than the 3-stone fire with wet fuel. The Philips natural draft stove requires woodfuel to be cut into pieces approximately 10 cm long, compared with other stoves tested that can use long woodfuel sticks.

F. Philips Power Stove HD4012. Compared to other wood-burning stoves tested, this stove had the highest cooking power [S8] and fastest time-to-boil [S9]. Thermal efficiency [S12] was high, combustion efficiency [S13] was high, and emissions of all pollutants were very low. The excellent performance of the stove was consistent with the performance of the Philips HD4010 stove previously tested¹. Compared to the Philips HD4008 natural draft stove, the HD4012 fan stove had much lower emissions of PM_{2.5} [S35], but similar emissions of UFPs [S67]. The rechargeable battery in the HD4012 is not removable, and the stove must be plugged into a source of electricity to recharge the battery. This Philips stove also requires woodfuel to be cut into shorter pieces approximately 10 cm long, compared with other stoves tested that can use long, woodfuel sticks.

G. Sampada Gasifier Stove. Compared to other wood-fueled stoves tested, cooking power [S8] was approximately in the middle of the range of values. Thermal efficiency [S12] for the Sampada stove was better than for the 3-stone fire, but not as good as for some of the other wood-fueled stoves. Compared with the 3-stone fire, fuel consumption [S17] was lower at high power (cold start and hot start) but was nearly the same at low power (simmer). Compared with the 3-stone fire, emissions of CO [S27] and PM_{2.5} [S35] were lower, especially with wet fuel. The Sampada had a vertical tube in the center of the

combustion space that was supported by the bottom of the stove. During testing, the bottom of the stove warped due to combustion heat, and then the vertical tube slanted to one side. The manufacturer was consulted and responded that the bottom of the stove is now made of thicker metal to overcome the problem. The Sampada stove requires woodfuel to be cut into pieces approximately 20 cm long, compared with other stoves tested that can use long woodfuel sticks.

H. StoveTec Greenfire Wood Stove. Compared with the 3-stone fire, maximum cooking power [S8] was higher and time-to-boil [S9] was faster. The StoveTec stove was tested at maximum power and also at a medium power level (denoted by “med. pwr.” in the database), for comparison with another rocket stove, the Envirofit G-3300. For maximum power, four woodfuel sticks were burned, and for medium power, three sticks were burned. The medium power level for the StoveTec stove was similar to the maximum cooking power [S8] for the 3-stone fire. Compared with the 3-stone fire, thermal efficiency [S12] was much better and fuel consumption [S17] was much lower at all power levels. Pollutant emissions per WBT task [S27, 35, 43, 51, 59, 67] were lower at all power levels. Pollutant emissions were lower at the medium power level than at maximum power. Compared with the 3-stone fire, the StoveTec stove had much lower emissions, especially with wet fuel. Performance for the StoveTec and Envirofit rocket stoves was, in general, similar. The StoveTec stove developed thin, hairline cracks in the ceramic combustion chamber during testing. Cracks formed on stress relief grooves, but also on other areas of the cylindrical combustion chamber. It is not likely that these very small cracks affected performance during the testing.

I. Upesi Portable Stove. Compared with the 3-stone fire, cooking power [S8] was similar, and hence time-to-boil [S9] was similar. Thermal efficiency [S12] for the Upesi stove was a little better than for the 3-stone fire, but thermal efficiency for the Upesi stove was the lowest of all the non-chimney wood-burning stoves tested. Likewise, fuel consumption [S17] for the Upesi stove was a little lower than for the 3-stone fire, but fuel consumption for the Upesi stove was the highest among the non-chimney wood-burning stoves tested. CO emissions per mass of fuel [S24] were a little higher for the Upesi than for the 3-stone fire, but since the Upesi used a little less fuel, total CO emissions [S27] were similar for the Upesi stove and 3-stone fire. PM_{2.5} emissions [S35] were also similar for the Upesi stove and 3-stone fire. CH₄ emissions [S55] with wet fuel were higher for the Upesi stove than for the 3-stone fire. In summary, the Upesi stove did not demonstrate much of an improvement over the 3-stone fire in terms of fuel use or emissions. The Upesi stove is constructed from relatively heavy ceramic material – a heat sink that causes lower thermal efficiency. Nevertheless, the Upesi stove partially encloses the fire, so it may have advantages over a 3-stone fire. The stove may help prevent burns and house fires, and it may perform better than a 3-stone fire outdoors under windy conditions. The Upesi may provide better support for a round-bottomed pot than the typical 3-stone fire, and pot support is important for cooking certain foods that are viscous and require stirring.

J. GERES NLS (New Lao Stove). This charcoal stove had the highest cooking power [S8] among the stoves tested. Compared with most charcoal stoves tested, thermal efficiency [S12] and specific fuel consumption [S18] were approximately in the middle of the range of values, CO emissions per energy delivered to the cooking pot [S23] with dry fuel were low, and PM_{2.5} emissions per energy delivered to the cooking pot [S31] were approximately in the middle of the range of values for the cold start, and were high for the hot start. The GERES stove was the only charcoal stove tested that did not have a means for restricting the air flow to underneath the burning charcoal to reduce power during the simmer phase of the

WBT. Most charcoal stoves tested had a hinged door for this purpose. A sheet of aluminum foil was used to restrict air flow during the simmer phase, but a hinged door would have been more convenient.

K. Gyapa Stove. Compared with other charcoal stoves tested, cooking power [S8], thermal efficiency [S12], fuel consumption [S18], and CO and PM_{2.5} emissions per energy delivered to the cooking pot [S23, 31] were approximately in the middle of the range of values, except CO emissions during the hot start were high, and PM_{2.5} emissions with wet fuel during the hot start were high.

L-M. Jiko, Ceramic and Jiko, Metal. Both of these charcoal stoves had lower power compared with other charcoal stoves tested, and both were tested with the smaller standard cooking pot with 2 liters of water. Compared with the metal jiko tested, the ceramic jiko had slightly higher cooking power [S8] and faster time-to-boil [S10], but thermal efficiency [S12] and fuel consumption [S18] were nearly the same for both stoves. Although the ceramic jiko is usually considered to be an improvement over the common metal jiko, the ceramic jiko did not have lower emissions of CO and PM_{2.5} [S23, 31]. The ceramic jiko is likely more durable than the metal jiko. Compared with most other charcoal stoves tested, both jikos had lower cooking power [S8], lower thermal efficiency [S12] during the cold start, and higher fuel consumption [S18] during the cold start and simmer. CO emissions per energy delivered to the cooking pot [S23] were high for both jikos with dry fuel during the cold start. PM_{2.5} emissions [S31] were high for both jikos for the cold start.

N. KCJ (Kenya Ceramic Jiko) Standard Stove. Compared with other charcoal stoves tested, cooking power [S8] was in the middle of the range of values, thermal efficiency [S12] was high (especially during the hot start with dry fuel), fuel consumption [S18] was low, and CO and PM_{2.5} emissions per energy delivered to the cooking pot [S23, 31] were approximately in the middle of the range of values.

O. Kenya Uhai Stove. Compared with other charcoal stoves tested, cooking power [S8] was in the middle of the range of values, thermal efficiency [S12] was high (especially during the cold start), fuel consumption [S18] was low, CO emissions [S23] were low, and PM_{2.5} emissions [S31] were low for the cold start.

P. StoveTec Prototype Charcoal Stove. Compared with other charcoal stoves tested, cooking power [S8] was approximately in the middle of the range of values. Thermal efficiency [S12] for the StoveTec stove was comparable to other charcoal stoves tested for the hot start, but thermal efficiency for the cold start may have been better compared to other charcoal stoves because of the different igniting material (charcoal lighter fluid) that was used for the StoveTec stove. Compared to other charcoal stoves tested, fuel consumption [S18] was low, and emissions of CO [S23] and PM_{2.5} [S31] were low, although emissions for the cold start may have been lower due to the different igniting material used. For this prototype stove, the vertical cylindrical core in the charcoal chamber was made out of perforated mild steel, but for a production stove, this part would likely need to be made of a different material that could better withstand the high temperature of charcoal combustion.

Q. Belonio Rice Husk Gas Stove. A smaller size stove (of two models) with a reactor diameter of 12 cm and height of 40 cm was tested. This stove was designed for low power, and it had the lowest cooking power [S8] during the hot start phase of all the stoves tested. It was the only stove tested with the pot lid on, because it would not bring 2 liters of water to a full boil with the lid off. The stove was tested with the pot lid off during the simmer phase to maintain the required temperature of the water per the WBT

protocol. The stove had a control for varying the rotational speed of the fan, but the stove was tested with nearly full fan speed during simmer. If the fan speed was set too low, the flame went out, and a large amount of smoke was produced. The rice hull fuel was easy to ignite, and the stove required no tending while the batch of fuel burned for up to 30 minutes. Compared with most non-charcoal stoves tested, PM_{2.5} emissions [S31] were low, but CO emissions [S23] were high. The stove requires electricity to operate the fan, and an interruption of power causes the flame to go out and a large amount of smoke to be produced. The ability to use abundantly available waste rice hulls as fuel is an important advantage of this stove.

R. Mayon Turbo Stove 7000. Cooking power [S8] for this rice-husk fueled stove was higher than for the Belonio Rice Husk stove, and power was sufficient to bring 5 liters of water to a full boil. Compared with the Belonio stove, thermal efficiency [S12] was lower, fuel consumption [S19] was higher, CO emissions [S23] were lower, and PM_{2.5} emissions [S31] were higher. Operation of the stove requires that the user tap on the side of the fuel hopper to feed fuel to the combustion area, and the power level of the stove is controlled by the amount of tapping. More frequent tapping on the hopper to feed a smaller amount of fuel at a time resulted in lower emissions, and the stove was tapped approximately every two minutes during the testing. The rice hull fuel was easy to ignite. An important advantage of this stove is the ability to burn abundantly available waste rice hulls, and it does not require electricity to operate a fan.

S. Oorja Stove. Cooking power [S8] was less than 1,000 watts for this pellet-fueled stove, so the stove was tested with the smaller sized pot and 2 liters of water. Thermal efficiency [S12] for the Oorja stove was approximately two times that of the 3-stone fire. Compared with other stoves tested, combustion efficiency [S13] was high, and emissions of most pollutants [S31, 47, 55, 63] were much lower than for the 3-stone fire. CO emissions per WBT task [S28] were notably higher at low power than at high power. Compared to other stoves tested, the Oorja stove had greater variation in emissions, and this variation may have been caused by an intermittent problem with the fan speed controller. During testing, the fan speed occasionally slowed, and then the power level of the stove dropped. When this problem occurred, the fan speed controller was bypassed and battery voltage was applied directly to the fan. If electrical power to the fan was interrupted, such as when a battery was momentarily removed, then the flame went out and a large amount of smoke was produced. An extra rechargeable battery received with the stove was defective and would not hold a charge. The stove required no tending while the batch of fuel burned for up to 70 minutes.

T. StoveTec Prototype TLUD Stove. Cooking power [S8] was less than 1,000 watts for this TLUD stove, so it was tested it with the smaller pot with 2 liters of water. Compared with all the stoves tested, this stove had the highest thermal efficiency [S12]. Compared with all stoves, combustion efficiency [S13] was also high, energy consumption [S20] was low, and emissions of all pollutants were low. Among the stoves tested, this stove was exceptional, because it performed so well with natural draft (without a fan), although it required processed fuel (wood pellets). The stove required no tending while the batch of fuel burned for approximately two hours. A test of the TLUD stove was attempted with high-moisture fuel, but combustion could not be maintained.

U. Jinqilin CKQ-80I Stove. Compared with other stoves tested, this corn-cob fueled stove had cooking power [S8] in the middle of the range of values. Thermal efficiency [S12] was low, as found for other stoves with a relatively large amount of thermal mass¹, and specific energy consumption [S20] was high.

CO emissions [S23] were high and were in the same range as emissions from charcoal stoves. Furthermore, CO emissions with wet fuel during the cold start were the highest compared to all stoves tested. PM_{2.5}, THC, and CH₄ emissions [S31, 47, 55] were also among the highest for all stoves tested and were especially high with wet fuel during the cold start. Attempts were made to reduce emissions by adjusting the controls for primary and secondary air. Training and assistance in operating the stove were provided by a consultant with experience operating and testing the stove in China. Controls were adjusted based on observations of the real-time air pollutant monitors, but emissions could not be reduced to a lower level. The primary air control was easy to inadvertently close, and when primary air flow was momentarily interrupted, then the flame went out, and a very large amount of smoke was produced. The consultant mentioned that it was observed that stove users in China typically left the ash access door open about 1 cm, and it was found in this study that leaving the ash door slightly open provided enough air via natural convection to sustain the flame in the event the primary air was inadvertently shut off.

V. Protos Stove. Cooking power [S8] was less than 1,000 watts for this liquid-fueled stove, so it was tested with the smaller sized pot and 2 liters of water. Firepower [S7] and the fuel burning rate [S16] remained the same during the cold start, hot start, and simmer, but cooking power was reduced during the simmer phase by placing the “simmer plate” (provided with the stove) between the burner and the pot. The stove required approximately 30 mL of alcohol fuel to preheat the burner before operation with plant oil fuel. Compared with the 3-stone fire, thermal efficiency [S12] was more than twice as high, and compared to all the stoves tested, combustion efficiency [S13] was high, and CO emissions [S23] were low. However, PM_{2.5} emissions [S31] were high, and variation in PM_{2.5} emissions was high, likely due to malfunction of the burner. The burner was cleaned after every test (less than 1.5 hours of stove operation), although the manufacturer recommended cleaning the burner after every five hours of operation. The burner assembly was completely disassembled, cleaned using the tools provided with the stove for this purpose, and then reassembled, as recommended by the manufacturer. Nevertheless, the burner orifice occasionally became partially obstructed with a resulting reduction of cooking power. When the orifice became obstructed during testing, it was cleaned with the fine wire tool (provided with the stove) while the stove was in operation, as recommended. During this process, occasionally the flame went out. Sometimes re-ignition of the flame was possible, but occasionally re-ignition was not possible, and then the bottom of the pot and the stove were sprayed with liquid fuel oil from the burner. For the cases when re-ignition was not possible, the test data were not included in the results reported in this article. The manufacturer was consulted and responded that the stove tested had a defective burner and that the problem has since been corrected.

9. Testing under Controlled Conditions versus Field Conditions

To obtain useful test results, a cookstove needs to be considered part of a system comprised of the stove (including chimney, if equipped), fuel (composition, moisture and size), cooking pot, pot skirt (if available), and operating procedure. Definition of appropriate realistic cookstove systems is important so that testing under controlled conditions is relevant and reflective of use in the field. Controlled testing cannot duplicate field testing, but to the extent practicable, controlled test conditions should emulate field conditions¹⁸. Results of cookstove testing under controlled conditions have often not been predictive of results under field conditions, especially when controlled and field test conditions are dissimilar^{17-18, 21-22}. Expanded field research is needed to provide critical information on actual use conditions that cannot be obtained from controlled tests. Continued research is also needed to develop controlled test methods that

better emulate field conditions, because controlled testing provides cost-effective evaluation of cookstoves with control of variables that is difficult or impossible to achieve in the field. Controlled testing can serve to inform the design stage of cookstoves and can provide a benchmark before the field stage. Results obtained under controlled conditions are not a substitute for results under field conditions, but controlled testing complements field testing. Appropriately defined cookstove systems can be tested under controlled conditions and compared using applicable metrics, as discussed in the article.

A fundamental difference between controlled and field conditions is the way solid fuel is used. Solid fuel will continue to burn/smolder after cooking itself ends. Measuring emissions only during the cooking cycle thus results in an unmeasured bias against cleaner fuel stoves (gaseous and liquid fuels) that can easily be turned off and those solid fuel stoves with small fueling batches that produce relatively little emissions afterwards. Protocols for systematically determining the contribution to emissions and fuel demand during the post-cooking cycle are needed.

Stoves using processed fuels required less operator attention than other stoves that required regular manual fuel feeding. The Philips HD4012 fan stove required manual fuel feeding, but forced draft provided consistent combustion conditions, and compared with other manually fed stoves, performance was less dependent on the operator. Since operator behavior can have a large effect on test results, it will likely be easier to obtain consistent results between laboratory and field tests for stoves that require less operator attention. For example, Johnson²³ recently reported consistent results between laboratory and field tests for the Oorja stove that uses batch loading of processed biomass pellet fuel.

10. Combustion Efficiency, Heat Transfer Efficiency, and Overall Thermal Efficiency. MCE (modified combustion efficiency), $\text{CO}_2/(\text{CO}_2+\text{CO})$ on a carbon basis, is a reasonable proxy for combustion efficiency (CO_2 carbon/total emitted carbon), and MCE indicates how well fuel is burned, i.e., how much of the potential energy in the fuel is converted to heat and radiant energy. A full accounting would include all the carbon in the products of incomplete combustion, and actual combustion efficiency would weight the products of incomplete combustion by their remaining potential chemical energy^{15,24}. HTE (heat transfer efficiency) is the ratio of energy delivered to the cooking pot versus the total heat energy released from the fuel combustion. OTE (overall thermal efficiency), which directly relates to fuel consumption, therefore is

$$\text{OTE} \sim \text{MCE} \times \text{HTE} \quad (1)$$

Emissions of pollutants (in products of incomplete combustion) that harm health are a strong function of MCE. It is important to distinguish the internal efficiencies, MCE and HTE, because these are sensitive to different kinds of design parameters. Many so-called improved stoves in the past, for example, increased OTE (lowered fuel use) by improving HTE (improved heat transfer to the pot), but in the process reduced MCE, thereby actually increasing emissions per meal or per mass of fuel²⁴.

11. Tiers of Performance

Test results from this study are mapped to Tiers defined in the recent ISO (International Organization for Standardization) IWA (International Workshop Agreement) entitled Guidelines for Evaluating Cookstove Performance²⁵. Higher Tier numbers reflect better performance. Results for Total Emissions (includes emissions from stove and chimney, if so equipped) are shown in Table SI-1. The single tier rating is

based on the lowest score from the four emissions criteria (sub-tiers) defined in the ISO IWA. Results for Indoor Emissions (does not include emissions from chimney, if so equipped) are shown in Table SI-2.

Table SI-1. Total Emissions – Tiers of Performance

Fuel	Cookstove	Tier	CO				PM2.5			
			High Power (g/MJ _{delivered})		Low power (g/min/L)		High Power (g/MJ _{delivered})		Low power (mg/min/L)	
			Sub-Tier		Sub-Tier		Sub-Tier		Sub-Tier	
Wood	3 Stone carefully tended	0	11.2	1	0.230	0	719	1	10.0	0
	3 Stone minimally tended	0	15.1	1	0.288	0	1350	0	16.5	0
	Berkeley Darfur	1	5.2	4	0.093	3	277	2	4.1	1
	Envirofit G-3300	1	5.1	4	0.080	4	478	1	2.7	2
	Envirofit G-3300, reduced fuel feed	2	3.4	4	0.070	4	300	2	2.2	2
	Onil	1	5.7	4	0.109	2	793	1	5.7	1
	Philips HD4012 fan	3	1.0	4	0.015	4	62	3	0.7	4
	Philips HD4008 Natural Draft	1	5.2	4	0.044	4	702	1	6.8	1
	Sampada	0	8.9	3	0.072	4	623	1	8.4	0
	StoveTec GreenFire	2	6.3	4	0.062	4	377	2	3.2	2
	StoveTec GreenFire, reduced fuel feed	2	4.3	4	0.060	4	351	2	3.4	2
	Upesi Portable	1	10.9	2	0.143	1	914	1	7.7	1
Charcoal	GERES	0	21.7	0	0.176	1	507	1	1.1	3
	Gyapa	0	36.8	0	0.289	0	477	1	1.5	3
	Jiko Ceramic	0	38.5	0	0.413	0	615	1	3.1	2
	Jiko Metal	0	35.9	0	0.379	0	644	1	0.9	4
	KCJ Standard	0	30.0	0	0.094	3	299	2	0.4	4
	Kenya Uhai	0	24.8	0	0.111	2	309	2	0.3	4
	StoveTec Charcoal	1	15.7	1	0.104	2	502	1	1.5	3
Rice hulls	Belonio	0	16.0	1	0.274	0	191	2	11.3	0
	Mayon Turbo	0	13.0	1	0.167	1	479	1	9.2	0
Biomass pellets	Oorja stove	0	2.0	4	0.237	0	75	3	4.2	1
Wood pellets	StoveTec TLUD	3	0.9	4	0.049	4	93	3	1.7	3
Corn cobs	Jinqilin CKQ-80I	0	37.8	0	0.468	0	1400	0	30.5	0
Plant oil	Protos	0	1.8	4	0.046	4	772	1	22.3	0

Table SI-2. Indoor Emissions – Tiers of Performance

Fuel	Cookstove	Tier	CO				PM2.5			
			High Power (g/min)		Low power (g/min)		High Power (mg/min)		Low power (mg/min)	
			Sub-Tier		Sub-Tier		Sub-Tier		Sub-Tier	
Wood	3 Stone carefully tended	0	0.885	1	0.984	0	56.9	0	42.8	0
	3 Stone minimally tended	0	1.041	0	1.232	0	93.8	0	70.2	0
	Berkeley Darfur	1	0.338	4	0.377	4	18.4	1	16.8	2
	Envirofit G-3300	0	0.558	2	0.340	4	52.6	0	11.3	2
	Envirofit G-3300, reduced fuel feed	1	0.258	4	0.302	4	23.2	1	9.3	2
	Onil	Not tested								
	Philips HD4012 fan	3	0.102	4	0.062	4	6.6	3	2.8	3
	Philips HD4008 Natural Draft	0	0.390	4	0.189	4	53.8	0	29.0	1
	Sampada	0	0.817	1	0.283	4	56.9	0	33.0	1
	StoveTec GreenFire	0	0.578	2	0.263	4	46.3	0	13.4	2
	StoveTec GreenFire, reduced fuel feed	1	0.313	4	0.258	4	25.1	1	14.7	2
	Upesi Portable	0	0.824	1	0.581	2	69.2	0	31.3	1
Charcoal	GERES	0	2.112	0	0.750	1	44.2	0	4.9	3
	Gyapa	0	2.183	0	1.197	0	26.0	1	6.4	3
	Jiko Ceramic	0	1.681	0	0.624	1	22.6	1	4.7	3
	Jiko Metal	0	1.334	0	0.552	2	17.5	1	1.3	4
	KCJ Standard	0	2.112	0	0.406	4	18.3	1	1.9	4
	Kenya Uhai	0	1.852	0	0.472	3	20.8	1	1.2	4
	StoveTec Charcoal	0	1.138	0	0.455	3	26.3	1	6.6	3
Rice hulls	Belonio	1	0.686	1	0.377	4	8.2	2	15.7	2
	Mayon Turbo	1	0.845	1	0.683	1	31.3	1	37.6	1
Biomass pellets	Oorja stove	3	0.087	4	0.350	4	2.9	3	6.1	3
Wood pellets	StoveTec TLUD	3	0.042	4	0.069	4	4.4	3	2.3	3
Corn cobs	Jinqilin CKQ-80I	Not tested								
Plant oil	Protos	1	0.078	4	0.073	4	34.5	1	34.8	1

Results for Efficiency / Fuel Use are shown in Table SI-3. The single tier rating is based on the lowest score from the two criteria (sub-tiers) defined in the IWA. Belonio, StoveTec TLUD, and Protos stoves had relatively high thermal efficiency at high power, but these stoves had limited capability for turning down the cooking power, and hence had high specific energy consumption on the low-power phase of the WBT.

Table SI-3. Efficiency / Fuel Use – Tiers of Performance

Fuel	Cookstove	Tier	High Power		Low power	
			Thermal		Specific Energy	
			Efficiency		Consumption	
			(%)	Sub-Tier	(MJ/min/L)	Sub-Tier
Wood	3 Stone carefully tended	0	14.9	0	0.066	0
	3 Stone minimally tended	0	13.7	0	0.068	0
	Berkeley Darfur	2	37.4	3	0.032	2
	Envirofit G-3300	2	39.4	3	0.031	2
	Envirofit G-3300, reduced fuel feed	3	38.2	3	0.026	3
	Onil	0	12.8	0	0.072	0
	Philips HD4012 fan	3	38.4	3	0.024	3
	Philips HD4008 Natural Draft	2	34.4	2	0.027	3
	Sampada	0	27.6	2	0.062	0
	StoveTec GreenFire	2	34.3	2	0.026	3
	StoveTec GreenFire, reduced fuel feed	3	36.1	3	0.028	3
	Upesi Portable	0	23.2	1	0.067	0
Charcoal	GERES	1	24.8	1	0.026	3
	Gyapa	2	26.5	2	0.026	3
	Jiko Ceramic	1	25.3	2	0.046	1
	Jiko Metal	0	24.3	1	0.052	0
	KCJ Standard	2	32.3	2	0.014	4
	Kenya Uhai	2	30.1	2	0.018	3
	StoveTec Charcoal	3	36.1	3	0.014	4
Rice hulls	Belonio	0	46.1	4	0.053	0
	Mayon Turbo	1	28.8	2	0.049	1
Biomass pellets	Oorja stove	2	34.7	2	0.032	2
Wood pellets	StoveTec TLUD	0	53.2	4	0.055	0
Corn cobs	Jinqilin CKQ-80I	0	13.4	0	0.129	0
Plant oil	Protos	0	36.9	3	0.073	0

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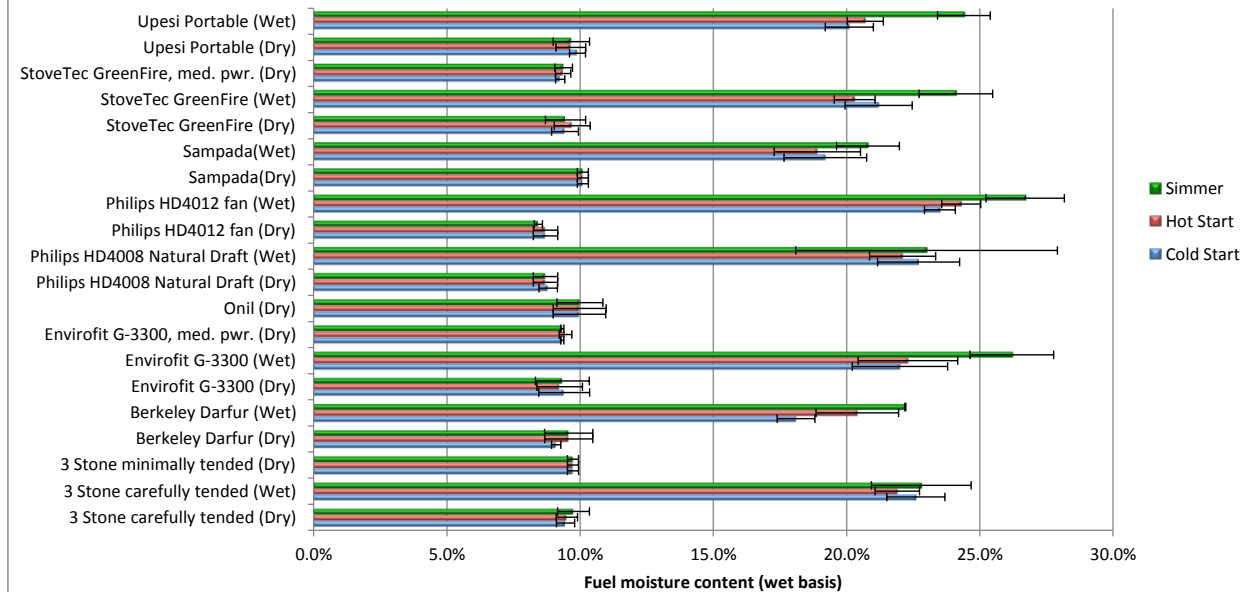
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Appendix: Emissions and Fuel Use Database

Table S1. Cookstove systems tested

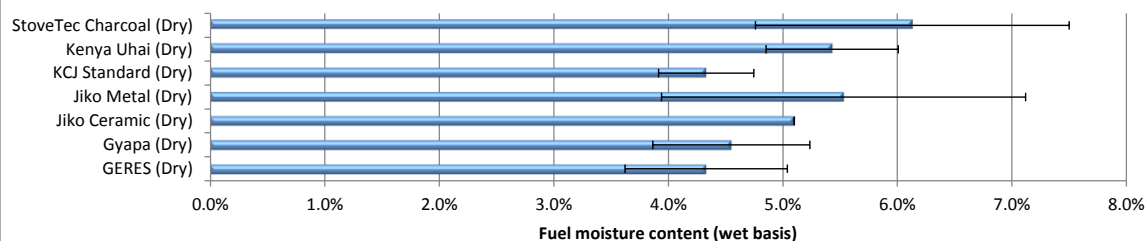
Descriptor: Stove, Fuel, Fuel moisture level	Cooking pot, water (liters)	Chimney	Pot Skirt	Operating procedure
3 Stone carefully tended, wood fuel (Dry)	Standard, 5			Fuel wood sticks continually fed so tips burned
3 Stone carefully tended, wood fuel (Wet)	Standard, 5			Fuel wood sticks continually fed so tips burned
3 Stone minimally tended, wood fuel (Dry)	Standard, 5			Fuel wood loaded in batches approximately every 10 minutes
Berkeley Darfur, wood fuel (Dry)	Round-bottomed, Cast Aluminum, 5		X	Per manufacturer's instructions
Berkeley Darfur, wood fuel (Wet)	Round-bottomed, Cast Aluminum, 5		X	Per manufacturer's instructions
Envirofit G-3300, wood fuel (Dry)	Standard, 5		X	Per manufacturer's instructions
Envirofit G-3300, wood fuel (Wet)	Standard, 5		X	Per manufacturer's instructions
Envirofit G-3300, med. pwr., wood fuel (Dry)	Standard, 5		X	Per manufacturer's instructions, but 3 fuel wood sticks used, rather than 4, for medium power level
Onil, wood fuel (Dry)	Standard, 5	X		Per manufacturer's instructions, used split fuel wood with larger size - maximum cross-section dimension: 4 cm
Philips HD4008 Natural Draft, wood fuel (Dry)	Standard, 5			Per manufacturer's instructions
Philips HD4008 Natural Draft, wood fuel (Wet)	Standard, 5			Per manufacturer's instructions
Philips HD4012 fan, wood fuel (Dry)	Standard, 5			Per manufacturer's instructions
Philips HD4012 fan, wood fuel (Wet)	Standard, 5			Per manufacturer's instructions
Sampada, wood fuel (Dry)	Standard, 5			Per manufacturer's instructions
Sampada, wood fuel (Wet)	Standard, 5			Per manufacturer's instructions
StoveTec GreenFire, wood fuel (Dry)	Standard, 5		X	Per manufacturer's instructions
StoveTec GreenFire, wood fuel (Wet)	Standard, 5		X	Per manufacturer's instructions
StoveTec GreenFire, med. pwr., wood fuel (Dry)	Standard, 5		X	Per manufacturer's instructions, but 3 fuel wood sticks used, rather than 4, for medium power level
Upesi Portable, wood fuel (Dry)	Round-bottomed, Cast Aluminum, 5			Per manufacturer's instructions
Upesi Portable, wood fuel (Wet)	Round-bottomed, Cast Aluminum, 5			Per manufacturer's instructions
GERES, charcoal fuel (Dry)	Standard, 5			Per manufacturer's instructions
GERES, charcoal fuel (Wet)	Standard, 5			Per manufacturer's instructions
Gyapa, charcoal fuel (Dry)	Standard, 5			Per manufacturer's instructions
Gyapa, charcoal fuel (Wet)	Standard, 5			Per manufacturer's instructions
Jiko Ceramic, charcoal fuel (Dry)	Standard, 2			Per instructions from consultant
Jiko Ceramic, charcoal fuel (Wet)	Standard, 2			Per instructions from consultant
Jiko Metal, charcoal fuel (Dry)	Standard, 2			Per instructions from consultant
Jiko Metal, charcoal fuel (Wet)	Standard, 2			Per instructions from consultant
KCJ Standard, charcoal fuel (Dry)	Standard, 5			Per manufacturer's instructions
KCJ Standard, charcoal fuel (Wet)	Standard, 5			Per manufacturer's instructions
Kenya Uhai, charcoal fuel (Dry)	Standard, 5			Per manufacturer's instructions
Kenya Uhai, charcoal fuel (Wet)	Standard, 5			Per manufacturer's instructions
StoveTec Charcoal, charcoal fuel (Dry)	StoveTec "Superpot", 5		X	Per manufacturer's instructions, used lighter fluid rather than solid starter used for other charcoal stoves
StoveTec Charcoal, charcoal fuel (Wet)	StoveTec "Superpot", 5		X	Per manufacturer's instructions, used lighter fluid rather than solid starter used for other charcoal stoves
Belonio, rice hull fuel (Dry)	Standard, 2			Per manufacturer's instructions
Belonio, rice hull fuel (Wet)	Standard, 2			Per manufacturer's instructions
Mayon Turbo, rice hull fuel (Dry)	Standard, 5			Per manufacturer's instructions
Mayon Turbo, rice hull fuel (Wet)	Standard, 5			Per manufacturer's instructions
Oorja stove, Oorja pellet fuel (Dry)	Standard, 2			Per manufacturer's instructions
Oorja stove, Oorja pellet fuel (Wet)	Standard, 2			Per manufacturer's instructions
StoveTec TLUD, wood pellet fuel (Dry)	Standard, 2		X	Per manufacturer's instructions
Jinqilin CKQ-80l, corn cob fuel (Dry)	Standard, 5	X		Per instructions from consultant
Jinqilin CKQ-80l, corn cob fuel (Wet)	Standard, 5	X		Per instructions from consultant
Protos, plant oil fuel	Standard, 2			Per manufacturer's instructions

Figure S2. Fuel Moisture Content - Wood



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended (Dry)	9.5%	0.3%	9.5%	0.4%	9.8%	0.6%
3 Stone carefully tended (Wet)	22.6%	1.1%	21.9%	0.8%	22.8%	1.9%
3 Stone minimally tended (Dry)	9.7%	0.2%	9.7%	0.2%	9.7%	0.2%
Berkeley Darfur (Dry)	9.1%	0.2%	9.6%	0.9%	9.6%	0.9%
Berkeley Darfur (Wet)	18.1%	0.7%	20.4%	1.6%	22.2%	0.0%
Envirofit G-3300 (Dry)	9.4%	1.0%	9.2%	0.9%	9.3%	1.0%
Envirofit G-3300 (Wet)	22.0%	1.8%	22.3%	1.9%	26.2%	1.6%
Envirofit G-3300, med. pwr. (Dry)	9.3%	0.1%	9.5%	0.2%	9.3%	0.1%
Onil (Dry)	10.0%	1.0%	10.0%	1.0%	10.0%	0.9%
Philips HD4008 Natural Draft (Dry)	8.8%	0.3%	8.7%	0.5%	8.7%	0.5%
Philips HD4008 Natural Draft (Wet)	22.7%	1.5%	22.1%	1.2%	23.0%	4.9%
Philips HD4012 fan (Dry)	8.7%	0.5%	8.7%	0.5%	8.4%	0.2%
Philips HD4012 fan (Wet)	23.5%	0.6%	24.3%	0.7%	26.7%	1.5%
Sampada(Dry)	10.1%	0.2%	10.1%	0.2%	10.1%	0.2%
Sampada(Wet)	19.2%	1.6%	18.9%	1.6%	20.8%	1.2%
StoveTec GreenFire (Dry)	9.4%	0.5%	9.7%	0.7%	9.5%	0.8%
StoveTec GreenFire (Wet)	21.2%	1.3%	20.3%	0.8%	24.1%	1.4%
StoveTec GreenFire, med. pwr. (Dry)	9.3%	0.2%	9.4%	0.3%	9.4%	0.3%
Upesi Portable (Dry)	9.9%	0.3%	9.7%	0.6%	9.7%	0.7%
Upesi Portable (Wet)	20.1%	0.9%	20.7%	0.7%	24.4%	1.0%

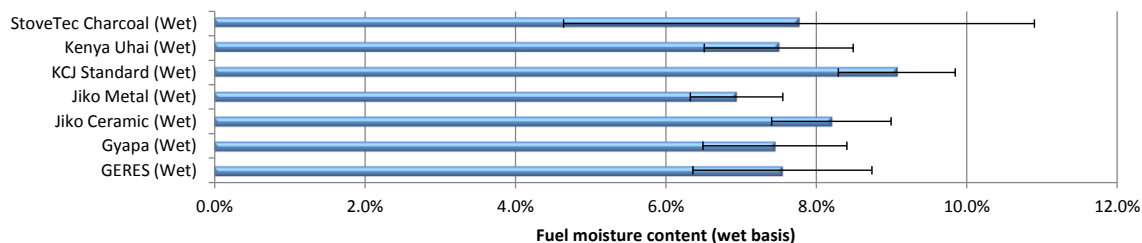
Figure S3. Fuel Moisture Content - Low-Moisture Charcoal



Cold Start

	Average	Std. Dev.
GERES (Dry)	4.3%	0.7%
Gyapa (Dry)	4.6%	0.7%
Jiko Ceramic (Dry)	5.1%	0.0%
Jiko Metal (Dry)	5.5%	1.6%
KCJ Standard (Dry)	4.3%	0.4%
Kenya Uhai (Dry)	5.4%	0.6%
StoveTec Charcoal (Dry)	6.1%	1.4%
		0.8%

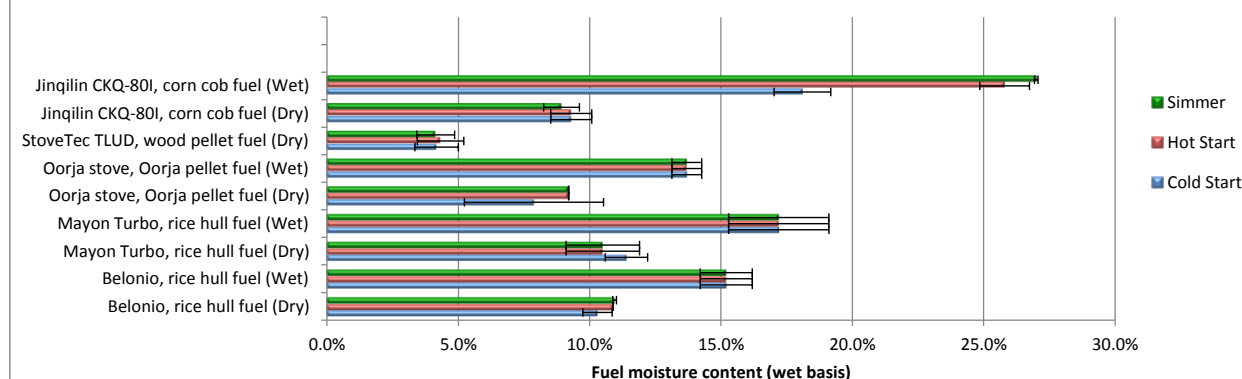
Figure S4. Fuel Moisture Content - High-Moisture Charcoal



Cold Start

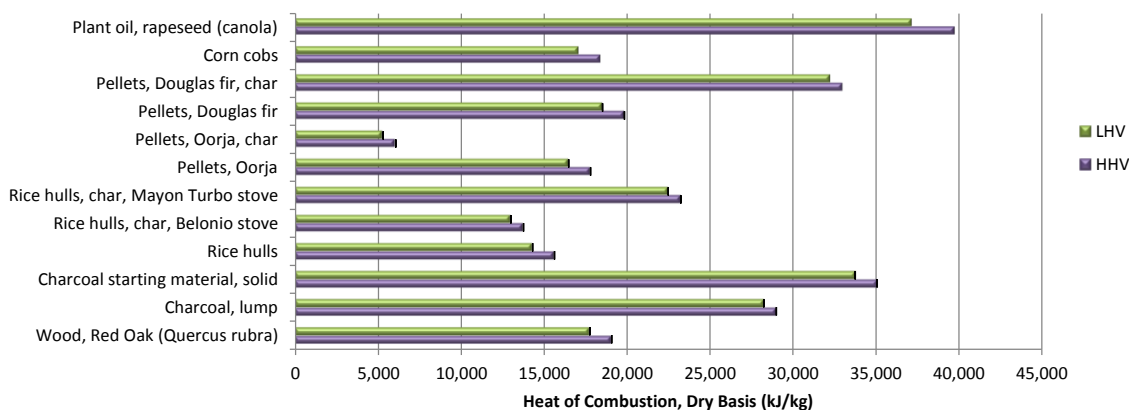
	Average	Std. Dev.
GERES (Wet)	7.6%	1.2%
Gyapa (Wet)	7.5%	1.0%
Jiko Ceramic (Wet)	8.2%	0.8%
Jiko Metal (Wet)	6.9%	0.6%
KCJ Standard (Wet)	9.1%	0.8%
Kenya Uhai (Wet)	7.5%	1.0%
StoveTec Charcoal (Wet)	7.8%	3.1%

Figure S5. Fuel Moisture Content - Other Solid Fuels



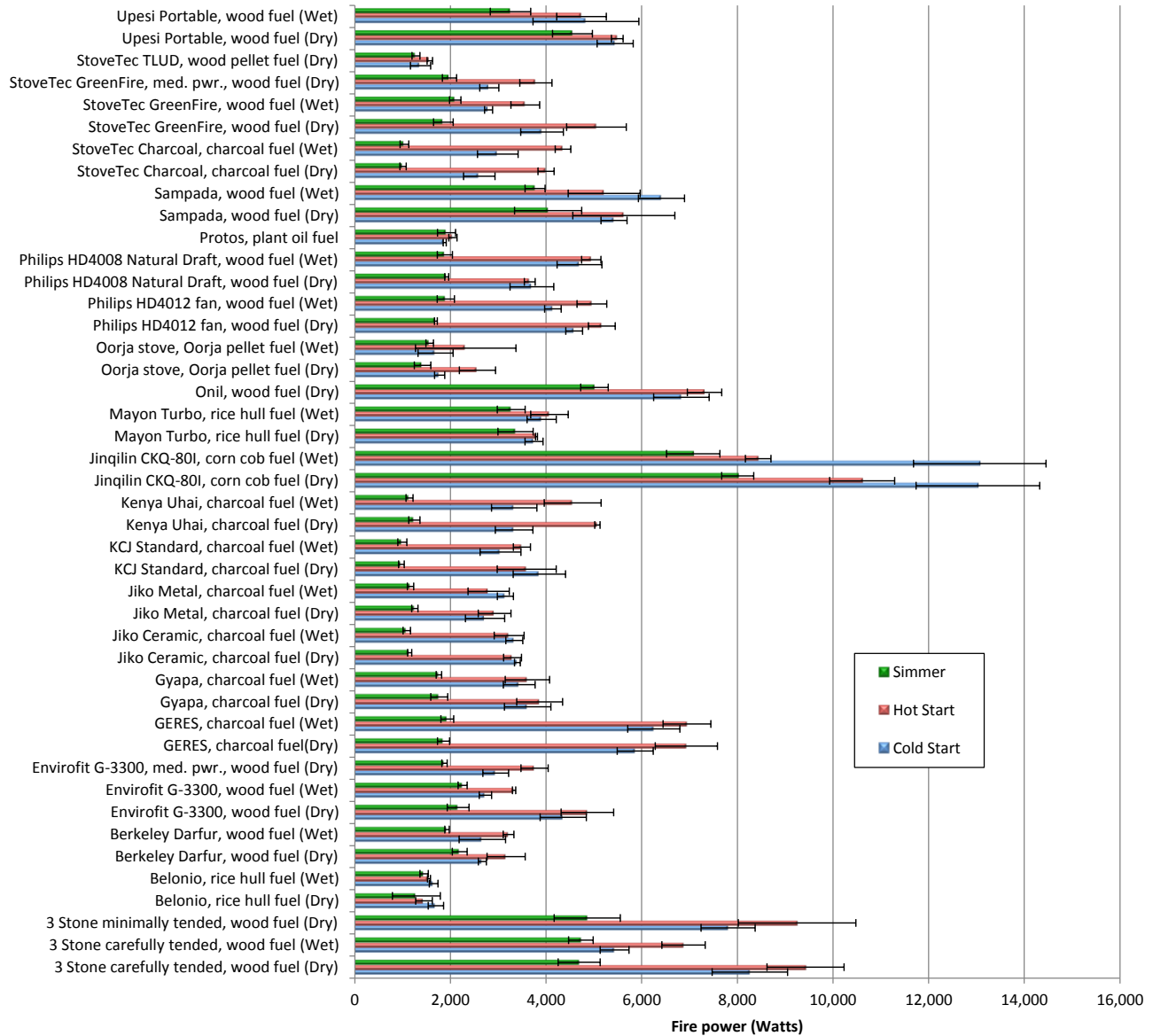
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	10.3%	0.6%	10.9%	0.0%	11.0%	0.1%
Belonio, rice hull fuel (Wet)	15.2%	1.0%	15.2%	1.0%	15.2%	1.0%
Mayon Turbo, rice hull fuel (Dry)	11.4%	0.8%	10.5%	1.4%	10.5%	1.4%
Mayon Turbo, rice hull fuel (Wet)	17.2%	1.9%	17.2%	1.9%	17.2%	1.9%
Oorja stove, Oorja pellet fuel (Dry)	7.9%	2.7%	9.2%	0.0%	9.2%	0.0%
Oorja stove, Oorja pellet fuel (Wet)	13.7%	0.6%	13.7%	0.6%	13.7%	0.6%
StoveTec TLUD, wood pellet fuel (Dry)	4.2%	0.8%	4.3%	0.9%	4.1%	0.7%
Jinqilin CKQ-80I, corn cob fuel (Dry)	9.3%	0.8%	9.3%	0.8%	8.9%	0.7%
Jinqilin CKQ-80I, corn cob fuel (Wet)	18.1%	1.1%	25.8%	0.9%	27.0%	0.1%

Figure S6. Fuel Energy Content



Fuel	Heat of Combustion	
	HHV - dry (KJ/kg)	LHV - dry (KJ/kg)
Wood, Red Oak (<i>Quercus rubra</i>)	19,062	17,742
Charcoal, lump	28,997	28,237
Charcoal starting material, solid	35,070	33,750
Rice hulls	15,614	14,294
Rice hulls, char, Belonio stove	13,744	12,984
Rice hulls, char, Mayon Turbo stove	23,233	22,473
Pellets, Oorja	17,788	16,468
Pellets, Oorja, char	6,038	5,278
Pellets, Douglas fir	19,833	18,513
Pellets, Douglas fir, char	32,970	32,210
Corn cobs	18,396	17,076
Plant oil, rapeseed (canola)	39,720	37,120

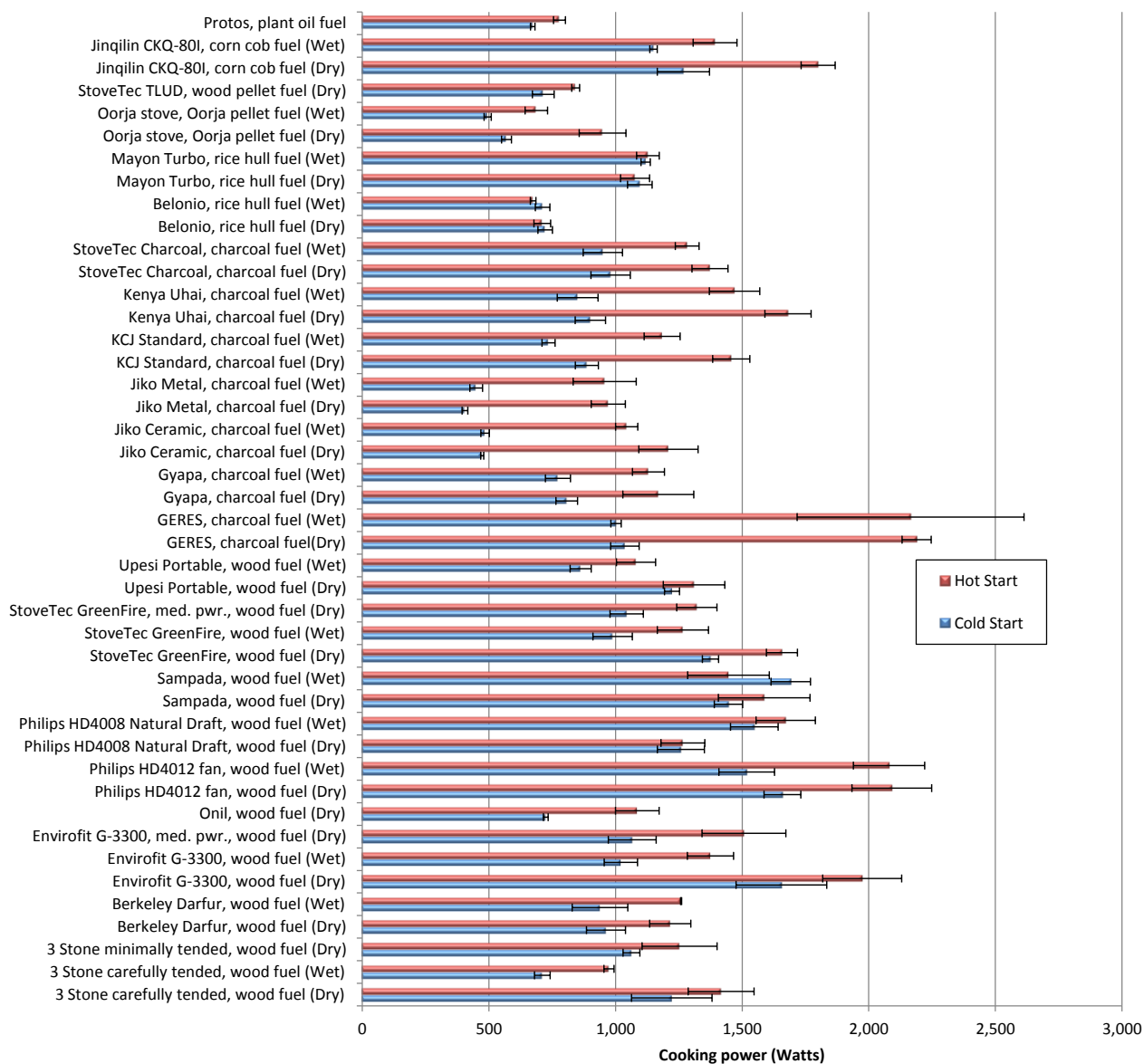
Figure S7. Fire Power



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	8,262	789	9,426	806	4,692	439
3 Stone carefully tended, wood fuel (Wet)	5,433	301	6,875	453	4,728	257
3 Stone minimally tended, wood fuel (Dry)	7,806	566	9,249	1,230	4,861	692
Belonio, rice hull fuel (Dry)	1,696	161	1,447	174	1,288	501
Belonio, rice hull fuel (Wet)	1,649	90	1,552	31	1,450	86
Berkeley Darfur, wood fuel (Dry)	2,668	84	3,165	399	2,194	155
Berkeley Darfur, wood fuel (Wet)	2,667	486	3,216	112	1,930	46
Envirofit G-3300, wood fuel (Dry)	4,359	483	4,864	550	2,161	228
Envirofit G-3300, wood fuel (Wet)	2,732	129	3,331	35	2,255	94
Envirofit G-3300, med. pwr., wood fuel (Dry)	2,948	269	3,760	284	1,876	56
GERES, charcoal fuel (Dry)	5,864	377	6,934	650	1,856	126
GERES, charcoal fuel (Wet)	6,253	545	6,946	499	1,935	134
Gyapa, charcoal fuel (Dry)	3,615	486	3,866	480	1,766	177
Gyapa, charcoal fuel (Wet)	3,439	332	3,609	464	1,759	57
Jiko Ceramic, charcoal fuel (Dry)	3,400	60	3,299	187	1,148	43

Jiko Ceramic, charcoal fuel (Wet)	3,336	178	3,228	313	1,087	77
Jiko Metal, charcoal fuel (Dry)	2,724	410	2,924	342	1,256	65
Jiko Metal, charcoal fuel (Wet)	3,149	168	2,799	431	1,166	66
KCJ Standard, charcoal fuel (Dry)	3,859	547	3,595	617	975	58
KCJ Standard, charcoal fuel (Wet)	3,048	427	3,495	179	994	94
Kenya Uhai, charcoal fuel (Dry)	3,332	393	5,073	55	1,246	117
Kenya Uhai, charcoal fuel (Wet)	3,334	475	4,556	595	1,144	73
Jinqilin CKQ-80l, corn cob fuel (Dry)	13,030	1,292	10,610	680	8,008	335
Jinqilin CKQ-80l, corn cob fuel (Wet)	13,070	1,385	8,436	268	7,077	558
Mayon Turbo, rice hull fuel (Dry)	3,748	188	3,800	20	3,362	368
Mayon Turbo, rice hull fuel (Wet)	3,908	305	4,071	392	3,271	292
Onil, wood fuel (Dry)	6,830	580	7,314	360	5,012	288
Oorja stove, Oorja pellet fuel (Dry)	1,775	107	2,565	378	1,417	172
Oorja stove, Oorja pellet fuel (Wet)	1,689	367	2,320	1,050	1,566	78
Philips HD4012 fan, wood fuel (Dry)	4,588	176	5,166	280	1,696	30
Philips HD4012 fan, wood fuel (Wet)	4,143	173	4,958	311	1,904	180
Philips HD4008 Natural Draft, wood fuel (Dry)	3,704	458	3,659	114	1,923	40
Philips HD4008 Natural Draft, wood fuel (Wet)	4,699	468	4,945	202	1,884	158
Protos, plant oil fuel	1,880	32	2,052	86	1,918	189
Sampada, wood fuel (Dry)	5,421	272	5,626	1,067	4,043	702
Sampada, wood fuel (Wet)	6,413	482	5,215	753	3,770	209
StoveTec Charcoal, charcoal fuel (Dry)	2,603	329	3,999	169	1,009	66
StoveTec Charcoal, charcoal fuel (Wet)	2,991	425	4,354	163	1,038	91
StoveTec GreenFire, wood fuel (Dry)	3,916	446	5,054	624	1,852	206
StoveTec GreenFire, wood fuel (Wet)	2,798	84	3,566	301	2,100	119
StoveTec GreenFire, med. pwr., wood fuel (Dry)	2,813	200	3,787	337	1,980	149
StoveTec TLUD, wood pellet fuel (Dry)	1,375	212	1,569	57	1,280	83
Upesi Portable, wood fuel (Dry)	5,445	377	5,489	122	4,552	417
Upesi Portable, wood fuel (Wet)	4,834	1,107	4,741	518	3,256	423

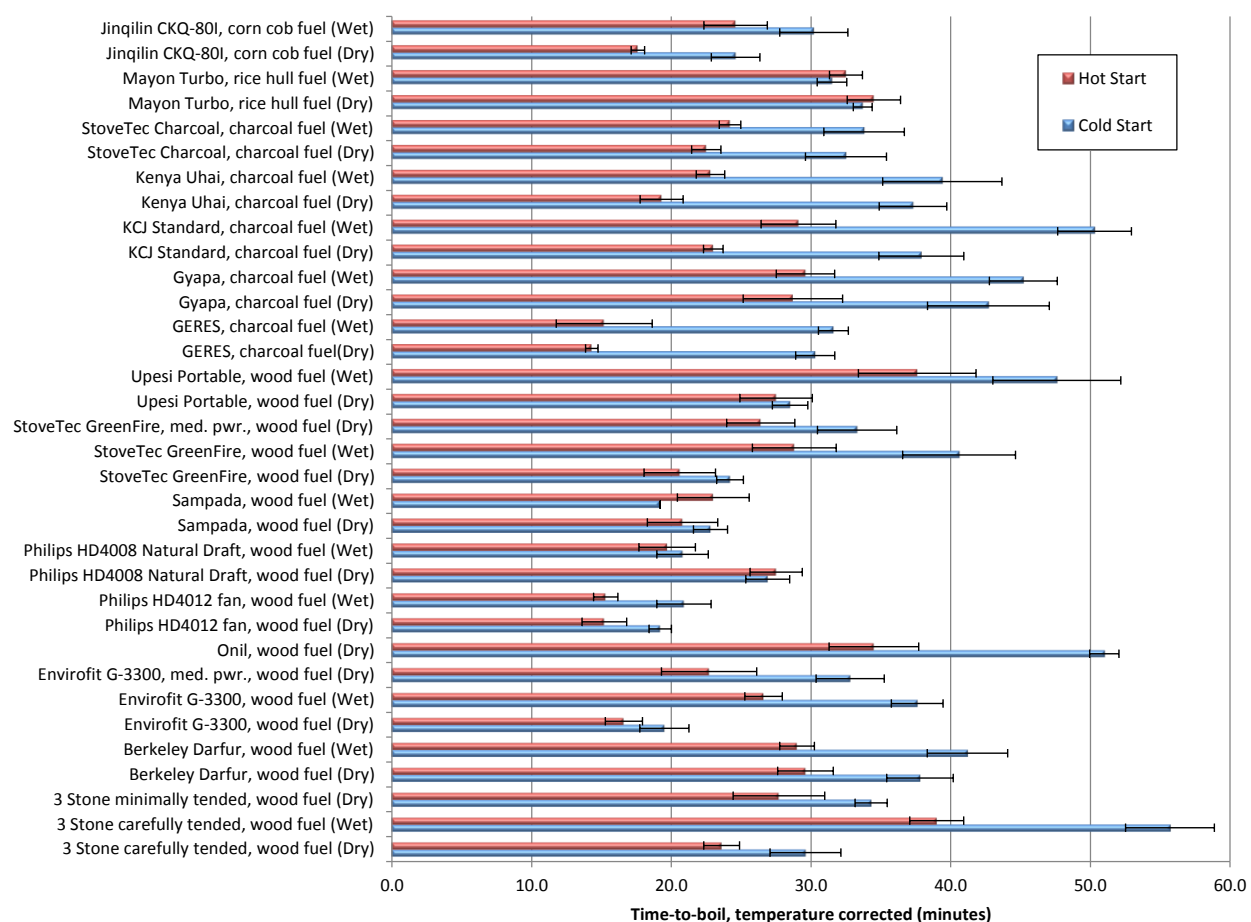
Figure S8. Cooking Power



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1,222	159	1,417	130
3 Stone carefully tended, wood fuel (Wet)	711	31	974	20
3 Stone minimally tended, wood fuel (Dry)	1,063	33	1,253	148
Berkeley Darfur, wood fuel (Dry)	962	77	1,216	81
Berkeley Darfur, wood fuel (Wet)	939	110	1,259	2
Envirofit G-3300, wood fuel (Dry)	1,655	179	1,974	156
Envirofit G-3300, wood fuel (Wet)	1,021	66	1,375	91
Envirofit G-3300, med. pwr., wood fuel (Dry)	1,066	94	1,507	166
Onil, wood fuel (Dry)	725	9	1,086	86
Philips HD4012 fan, wood fuel (Dry)	1,659	73	2,091	157
Philips HD4012 fan, wood fuel (Wet)	1,518	110	2,080	141
Philips HD4008 Natural Draft, wood fuel (Dry)	1,258	93	1,266	87
Philips HD4008 Natural Draft, wood fuel (Wet)	1,548	94	1,672	117
Sampada, wood fuel (Dry)	1,446	56	1,587	181
Sampada, wood fuel (Wet)	1,692	78	1,446	161
StoveTec GreenFire, wood fuel (Dry)	1,375	32	1,657	61

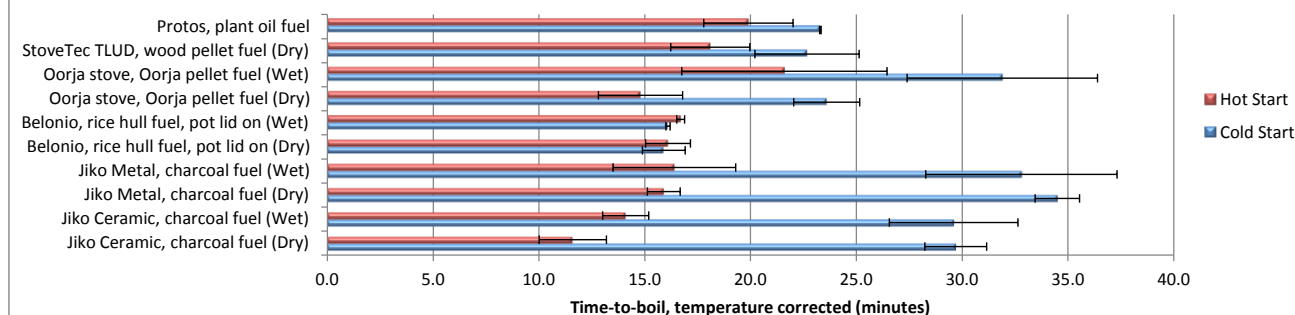
StoveTec GreenFire, wood fuel (Wet)	989	78	1,266	101
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1,044	66	1,321	79
Upesi Portable, wood fuel (Dry)	1,223	30	1,310	121
Upesi Portable, wood fuel (Wet)	862	42	1,081	77
GERES, charcoal fuel(Dry)	1,037	56	2,189	57
GERES, charcoal fuel (Wet)	1,002	20	2,165	448
Gyapa, charcoal fuel (Dry)	807	43	1,169	140
Gyapa, charcoal fuel (Wet)	773	50	1,130	63
Jiko Ceramic, charcoal fuel (Dry)	474	6	1,209	117
Jiko Ceramic, charcoal fuel (Wet)	485	17	1,044	44
Jiko Metal, charcoal fuel (Dry)	405	11	971	67
Jiko Metal, charcoal fuel (Wet)	450	25	957	125
KCJ Standard, charcoal fuel (Dry)	887	45	1,457	73
KCJ Standard, charcoal fuel (Wet)	736	26	1,184	71
Kenya Uhai, charcoal fuel (Dry)	901	60	1,681	91
Kenya Uhai, charcoal fuel (Wet)	850	81	1,470	100
StoveTec Charcoal, charcoal fuel (Dry)	981	78	1,373	71
StoveTec Charcoal, charcoal fuel (Wet)	950	78	1,283	47
Belonio, rice hull fuel (Dry)	722	29	711	33
Belonio, rice hull fuel (Wet)	712	29	675	11
Mayon Turbo, rice hull fuel (Dry)	1,096	49	1,077	57
Mayon Turbo, rice hull fuel (Wet)	1,119	18	1,128	45
Oorja stove, Oorja pellet fuel (Dry)	570	19	949	92
Oorja stove, Oorja pellet fuel (Wet)	495	14	687	44
StoveTec TLUD, wood pellet fuel (Dry)	715	43	843	16
Jinqilin CKQ-80l, corn cob fuel (Dry)	1,268	103	1,800	67
Jinqilin CKQ-80l, corn cob fuel (Wet)	1,150	15	1,393	87
Protos, plant oil fuel	673	9	779	24

Figure S9. Time-to-Boil - 5 Liters of Water



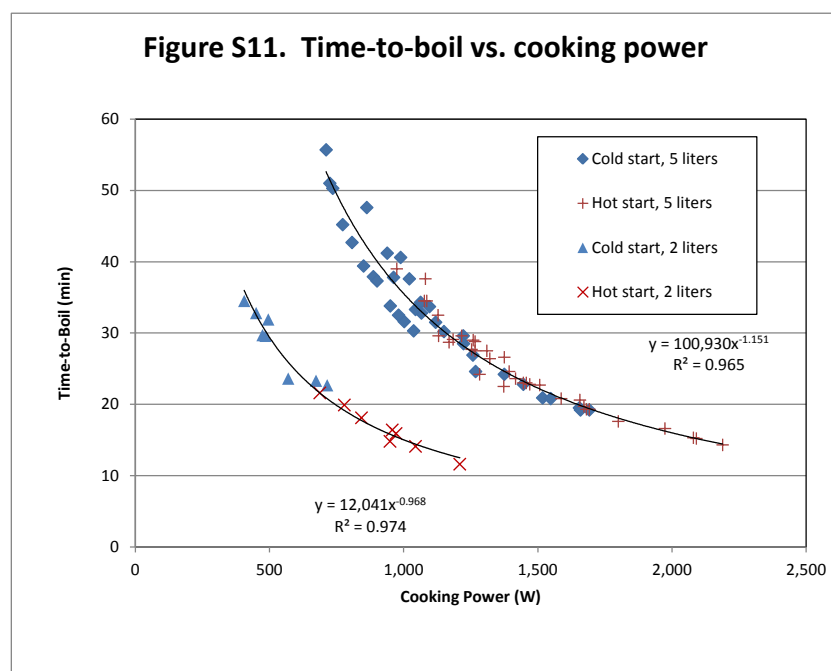
	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	29.6	2.5	23.6	1.3
3 Stone carefully tended, wood fuel (Wet)	55.7	3.2	39.0	1.9
3 Stone minimally tended, wood fuel (Dry)	34.3	1.2	27.7	3.3
Berkeley Darfur, wood fuel (Dry)	37.8	2.4	29.6	2.0
Berkeley Darfur, wood fuel (Wet)	41.2	2.9	29.0	1.2
Envirofit G-3300, wood fuel (Dry)	19.5	1.8	16.6	1.3
Envirofit G-3300, wood fuel (Wet)	37.6	1.9	26.6	1.3
Envirofit G-3300, med. pwr., wood fuel (Dry)	32.8	2.4	22.7	3.4
Onil, wood fuel (Dry)	51.0	1.1	34.5	3.2
Philips HD4012 fan, wood fuel (Dry)	19.2	0.8	15.2	1.6
Philips HD4012 fan, wood fuel (Wet)	20.9	1.9	15.3	0.9
Philips HD4008 Natural Draft, wood fuel (Dry)	26.9	1.6	27.5	1.9
Philips HD4008 Natural Draft, wood fuel (Wet)	20.8	1.8	19.7	2.0
Sampada, wood fuel (Dry)	22.8	1.2	20.8	2.5
Sampada, wood fuel (Wet)	19.2	0.0	23.0	2.6
StoveTec GreenFire, wood fuel (Dry)	24.2	1.0	20.6	2.6
StoveTec GreenFire, wood fuel (Wet)	40.6	4.0	28.8	3.0
StoveTec GreenFire, med. pwr., wood fuel (Dry)	33.3	2.8	26.4	2.4
Upesi Portable, wood fuel (Dry)	28.5	1.3	27.5	2.6
Upesi Portable, wood fuel (Wet)	47.6	4.6	37.6	4.2
GERES, charcoal fuel(Dry)	30.3	1.4	14.3	0.4
GERES, charcoal fuel (Wet)	31.6	1.1	15.2	3.4
Gyapa, charcoal fuel (Dry)	42.7	4.4	28.7	3.6
Gyapa, charcoal fuel (Wet)	45.2	2.4	29.6	2.1
KCJ Standard, charcoal fuel (Dry)	37.9	3.0	23.0	0.7
KCJ Standard, charcoal fuel (Wet)	50.3	2.6	29.1	2.7
Kenya Uhai, charcoal fuel (Dry)	37.3	2.4	19.3	1.5
Kenya Uhai, charcoal fuel (Wet)	39.4	4.3	22.8	1.0
StoveTec Charcoal, charcoal fuel (Dry)	32.5	2.9	22.5	1.1
StoveTec Charcoal, charcoal fuel (Wet)	33.8	2.9	24.2	0.8
Mayon Turbo, rice hull fuel (Dry)	33.7	0.7	34.5	1.9
Mayon Turbo, rice hull fuel (Wet)	31.5	1.1	32.5	1.2
Jinqilin CKQ-80I, corn cob fuel (Dry)	24.6	1.8	17.6	0.5
Jinqilin CKQ-80I, corn cob fuel (Wet)	30.2	2.4	24.6	2.3

Figure S10. Time-to-Boil - 2 Liters of Water



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
Jiko Ceramic, charcoal fuel (Dry)	29.7	1.5	11.6	1.6
Jiko Ceramic, charcoal fuel (Wet)	29.6	3.0	14.1	1.1
Jiko Metal, charcoal fuel (Dry)	34.5	1.1	15.9	0.8
Jiko Metal, charcoal fuel (Wet)	32.8	4.5	16.4	2.9
Belonio, rice hull fuel, pot lid on (Dry)	15.9	1.0	16.1	1.1
Belonio, rice hull fuel, pot lid on (Wet)	16.1	0.1	16.7	0.2
Oorja stove, Oorja pellet fuel (Dry)	23.6	1.6	14.8	2.0
Oorja stove, Oorja pellet fuel (Wet)	31.9	4.5	21.6	4.9
StoveTec TLUD, wood pellet fuel (Dry)	22.7	2.5	18.1	1.9
Protos, plant oil fuel	23.3	0.0	19.9	2.1

Figure S11. Time-to-boil vs. cooking power



	Cooking Power (W)	Time to Boil (min)
5 liters of water in cooking pot - Cold start		
3 Stone carefully tended, wood fuel (Dry)	1,222	29.6
3 Stone carefully tended, wood fuel (Wet)	711	55.7
3 Stone minimally tended, wood fuel (Dry)	1,063	34.3
Berkeley Darfur, wood fuel (Dry)	962	37.8
Berkeley Darfur, wood fuel (Wet)	939	41.2
Envirofit G-3300, wood fuel (Dry)	1,655	19.5
Envirofit G-3300, wood fuel (Wet)	1,021	37.6
Envirofit G-3300, med. pwr., wood fuel (Dry)	1,066	32.8
Onil, wood fuel (Dry)	725	51.0
Philips HD4012 fan, wood fuel (Dry)	1,659	19.2
Philips HD4012 fan, wood fuel (Wet)	1,518	20.9
Philips HD4008 Natural Draft, wood fuel (Dry)	1,258	26.9
Philips HD4008 Natural Draft, wood fuel (Wet)	1,548	20.8
Sampada, wood fuel (Dry)	1,446	22.8
Sampada, wood fuel (Wet)	1,692	19.2
StoveTec GreenFire, wood fuel (Dry)	1,375	24.2
StoveTec GreenFire, wood fuel (Wet)	989	40.6
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1,044	33.3
Upesi Portable, wood fuel (Dry)	1,223	28.5
Upesi Portable, wood fuel (Wet)	862	47.6
GERES, charcoal fuel (Dry)	1,037	30.3
GERES, charcoal fuel (Wet)	1,002	31.6
Gyapa, charcoal fuel (Dry)	807	42.7
Gyapa, charcoal fuel (Wet)	773	45.2
KCJ Standard, charcoal fuel (Dry)	887	37.9
KCJ Standard, charcoal fuel (Wet)	736	50.3
Kenya Uhai, charcoal fuel (Dry)	901	37.3
Kenya Uhai, charcoal fuel (Wet)	850	39.4
StoveTec Charcoal, charcoal fuel (Dry)	981	32.5
StoveTec Charcoal, charcoal fuel (Wet)	950	33.8
Mayon Turbo, rice hull fuel (Dry)	1,096	33.7
Mayon Turbo, rice hull fuel (Wet)	1,119	31.5
Jinqilin CKQ-80I, corn cob fuel (Dry)	1,268	24.6
Jinqilin CKQ-80I, corn cob fuel (Wet)	1,150	30.2

5 liters of water in cooking pot - Hot start

3 Stone carefully tended, wood fuel (Dry)	1,417	23.6
3 Stone carefully tended, wood fuel (Wet)	974	39.0
3 Stone minimally tended, wood fuel (Dry)	1,253	27.7
Berkeley Darfur, wood fuel (Dry)	1,216	29.6
Berkeley Darfur, wood fuel (Wet)	1,259	29.0
Envirofit G-3300, wood fuel (Dry)	1,974	16.6
Envirofit G-3300, wood fuel (Wet)	1,375	26.6
Envirofit G-3300, med. pwr., wood fuel (Dry)	1,507	22.7
Onil, wood fuel (Dry)	1,086	34.5
Philips HD4012 fan, wood fuel (Dry)	2,091	15.2
Philips HD4012 fan, wood fuel (Wet)	2,080	15.3
Philips HD4008 Natural Draft, wood fuel (Dry)	1,266	27.5
Philips HD4008 Natural Draft, wood fuel (Wet)	1,672	19.7
Sampada, wood fuel (Dry)	1,587	20.8
Sampada, wood fuel (Wet)	1,446	23.0
StoveTec GreenFire, wood fuel (Dry)	1,657	20.6
StoveTec GreenFire, wood fuel (Wet)	1,266	28.8
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1,321	26.4
Upesi Portable, wood fuel (Dry)	1,310	27.5
Upesi Portable, wood fuel (Wet)	1,081	37.6
GERES, charcoal fuel (Dry)	2,189	14.3
GERES, charcoal fuel (Wet)	1,692	19.3
Gyapa, charcoal fuel (Dry)	1,169	28.7
Gyapa, charcoal fuel (Wet)	1,130	29.6
KCJ Standard, charcoal fuel (Dry)	1,457	23.0
KCJ Standard, charcoal fuel (Wet)	1,184	29.1
Kenya Uhai, charcoal fuel (Dry)	1,681	19.3
Kenya Uhai, charcoal fuel (Wet)	1,470	22.8
StoveTec Charcoal, charcoal fuel (Dry)	1,373	22.5
StoveTec Charcoal, charcoal fuel (Wet)	1,283	24.2
Mayon Turbo, rice hull fuel (Dry)	1,077	34.5
Mayon Turbo, rice hull fuel (Wet)	1,128	32.5
Jinqilin CKQ-80I, corn cob fuel (Dry)	1,800	17.6
Jinqilin CKQ-80I, corn cob fuel (Wet)	1,393	24.6

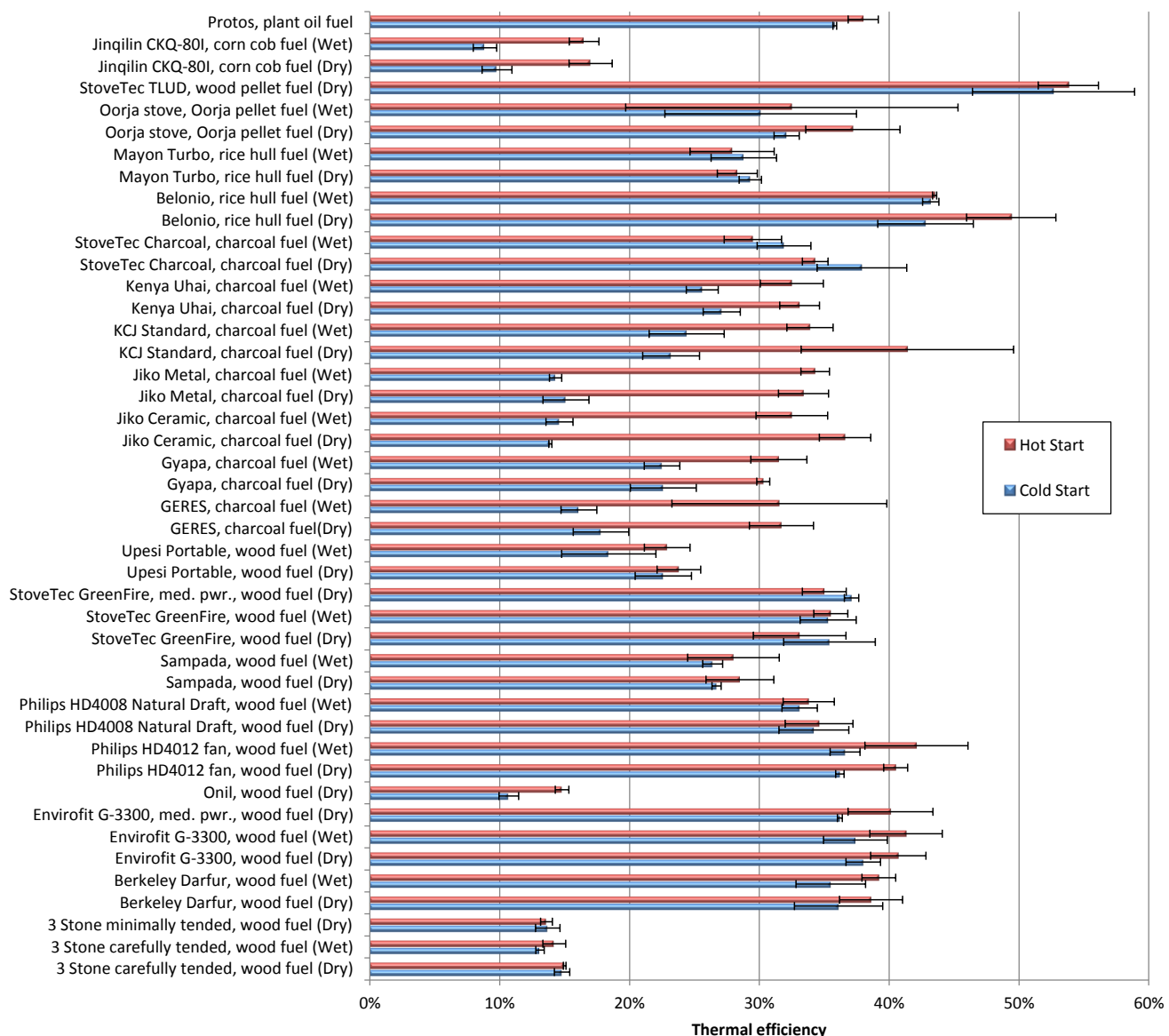
2 liters of water in cooking pot - Cold start

Jiko Ceramic, charcoal fuel (Dry)	474	29.7
Jiko Ceramic, charcoal fuel (Wet)	485	29.6
Jiko Metal, charcoal fuel (Dry)	405	34.5
Jiko Metal, charcoal fuel (Wet)	450	32.8
Oorja stove, Oorja pellet fuel (Dry)	570	23.6
Oorja stove, Oorja pellet fuel (Wet)	495	31.9
Protos, plant oil fuel	673	23.3
StoveTec TLUD, wood pellet fuel (Dry)	715	22.7

2 liters of water in cooking pot - Hot start

Jiko Ceramic, charcoal fuel (Dry)	1,209	11.6
Jiko Ceramic, charcoal fuel (Wet)	1,044	14.1
Jiko Metal, charcoal fuel (Dry)	971	15.9
Jiko Metal, charcoal fuel (Wet)	957	16.4
Oorja stove, Oorja pellet fuel (Dry)	949	14.8
Oorja stove, Oorja pellet fuel (Wet)	687	21.6
Protos, plant oil fuel	779	19.9
StoveTec TLUD, wood pellet fuel (Dry)	843	18.1

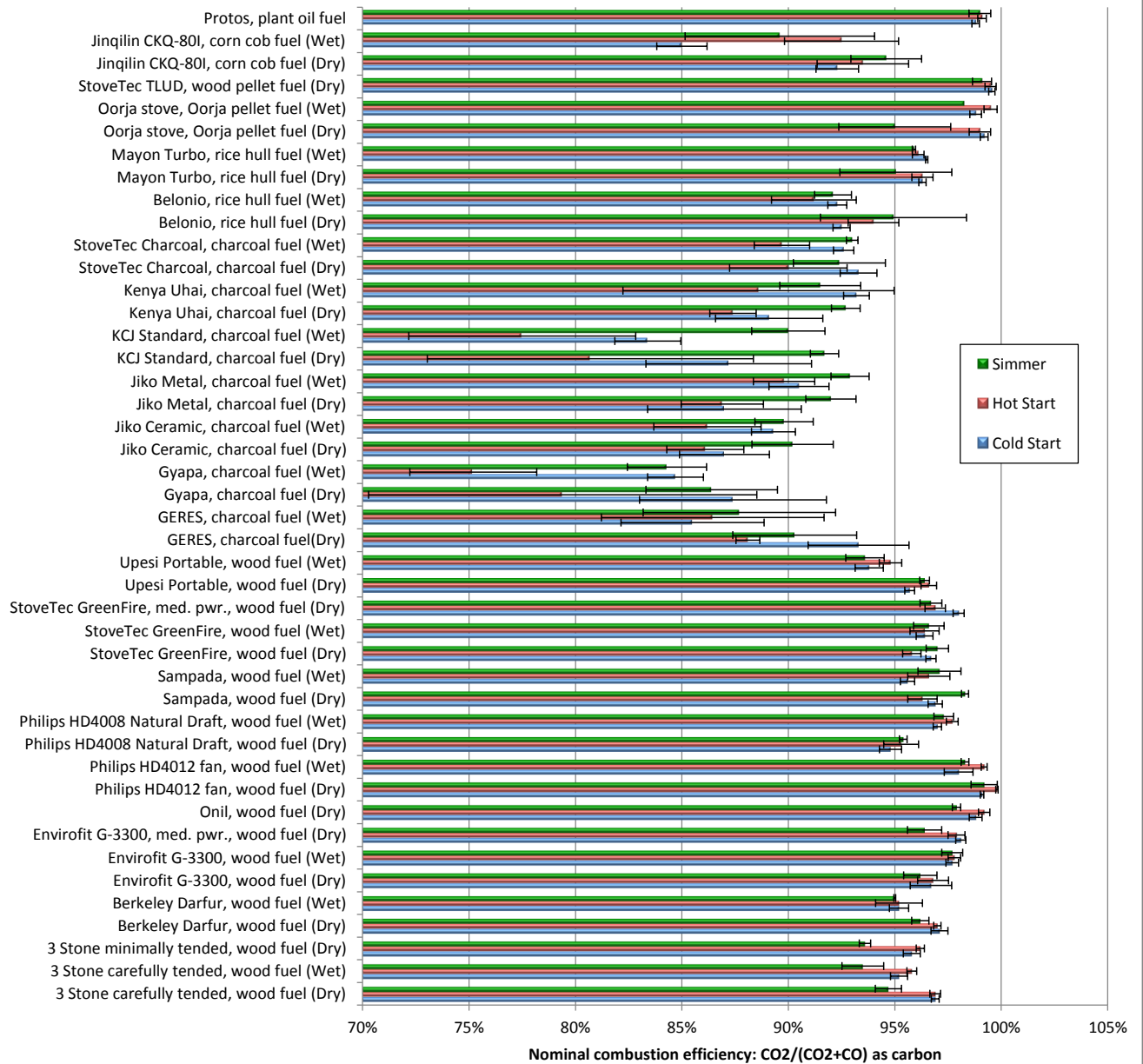
Figure S12. Overall Thermal Efficiency



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	14.8%	0.6%	15.0%	0.1%
3 Stone carefully tended, wood fuel (Wet)	13.1%	0.3%	14.2%	0.9%
3 Stone minimally tended, wood fuel (Dry)	13.7%	0.9%	13.6%	0.5%
Berkeley Darfur, wood fuel (Dry)	36.1%	3.4%	38.6%	2.4%
Berkeley Darfur, wood fuel (Wet)	35.5%	2.7%	39.2%	1.3%
Envirofit G-3300, wood fuel (Dry)	38.0%	1.3%	40.7%	2.1%
Envirofit G-3300, wood fuel (Wet)	37.4%	2.5%	41.3%	2.8%
Envirofit G-3300, med. pwr., wood fuel (Dry)	36.2%	0.2%	40.1%	3.3%
Onil, wood fuel (Dry)	10.7%	0.8%	14.8%	0.5%
Philips HD4012 fan, wood fuel (Dry)	36.2%	0.3%	40.5%	0.9%
Philips HD4012 fan, wood fuel (Wet)	36.6%	1.2%	42.1%	4.0%
Philips HD4008 Natural Draft, wood fuel (Dry)	34.2%	2.7%	34.6%	2.6%
Philips HD4008 Natural Draft, wood fuel (Wet)	33.1%	1.4%	33.8%	2.0%
Sampada, wood fuel (Dry)	26.7%	0.4%	28.5%	2.6%
Sampada, wood fuel (Wet)	26.4%	0.8%	28.0%	3.5%

StoveTec GreenFire, wood fuel (Dry)	35.4%	3.5%	33.1%	3.6%
StoveTec GreenFire, wood fuel (Wet)	35.3%	2.2%	35.5%	1.3%
StoveTec GreenFire, med. pwr., wood fuel (Dry)	37.1%	0.6%	35.0%	1.7%
Upesi Portable, wood fuel (Dry)	22.6%	2.2%	23.8%	1.7%
Upesi Portable, wood fuel (Wet)	18.4%	3.6%	22.9%	1.8%
GERES, charcoal fuel(Dry)	17.8%	2.1%	31.7%	2.5%
GERES, charcoal fuel (Wet)	16.1%	1.4%	31.5%	8.3%
Gyapa, charcoal fuel (Dry)	22.6%	2.5%	30.3%	0.5%
Gyapa, charcoal fuel (Wet)	22.5%	1.4%	31.5%	2.2%
Jiko Ceramic, charcoal fuel (Dry)	13.9%	0.1%	36.6%	2.0%
Jiko Ceramic, charcoal fuel (Wet)	14.6%	1.0%	32.5%	2.8%
Jiko Metal, charcoal fuel (Dry)	15.1%	1.8%	33.4%	1.9%
Jiko Metal, charcoal fuel (Wet)	14.3%	0.5%	34.3%	1.1%
KCJ Standard, charcoal fuel (Dry)	23.2%	2.2%	41.4%	8.2%
KCJ Standard, charcoal fuel (Wet)	24.4%	2.9%	33.9%	1.8%
Kenya Uhai, charcoal fuel (Dry)	27.1%	1.4%	33.1%	1.5%
Kenya Uhai, charcoal fuel (Wet)	25.6%	1.2%	32.5%	2.4%
StoveTec Charcoal, charcoal fuel (Dry)	37.9%	3.5%	34.3%	1.0%
StoveTec Charcoal, charcoal fuel (Wet)	31.9%	2.1%	29.5%	2.2%
Belonio, rice hull fuel (Dry)	42.8%	3.7%	49.4%	3.4%
Belonio, rice hull fuel (Wet)	43.2%	0.6%	43.5%	0.2%
Mayon Turbo, rice hull fuel (Dry)	29.3%	0.9%	28.3%	1.5%
Mayon Turbo, rice hull fuel (Wet)	28.8%	2.5%	27.9%	3.2%
Oorja stove, Oorja pellet fuel (Dry)	32.1%	1.0%	37.2%	3.6%
Oorja stove, Oorja pellet fuel (Wet)	30.1%	7.4%	32.5%	12.8%
StoveTec TLUD, wood pellet fuel (Dry)	52.7%	6.2%	53.8%	2.3%
Jinqilin CKQ-80I, corn cob fuel (Dry)	9.8%	1.2%	17.0%	1.7%
Jinqilin CKQ-80I, corn cob fuel (Wet)	8.9%	0.9%	16.5%	1.1%
Protos, plant oil fuel	35.8%	0.1%	38.0%	1.2%

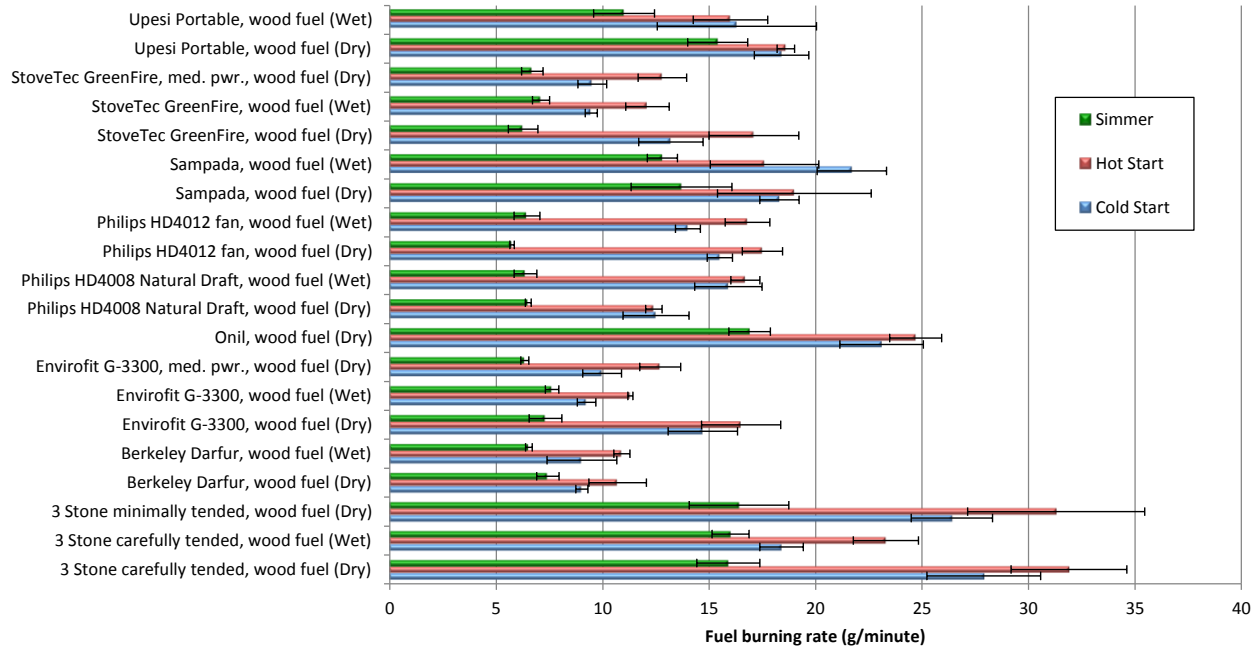
Figure S13. Modified Combustion Efficiency



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	96.9%	0.2%	96.9%	0.3%	94.7%	0.6%
3 Stone carefully tended, wood fuel (Wet)	95.2%	0.4%	95.8%	0.2%	93.5%	1.0%
3 Stone minimally tended, wood fuel (Dry)	95.8%	0.4%	96.2%	0.2%	93.6%	0.3%
Berkeley Darfur, wood fuel (Dry)	97.1%	0.4%	97.0%	0.2%	96.2%	0.4%
Berkeley Darfur, wood fuel (Wet)	95.2%	0.5%	95.2%	1.1%	95.0%	0.0%
Envirofit G-3300, wood fuel (Dry)	96.7%	1.0%	96.8%	0.7%	96.2%	0.8%
Envirofit G-3300, wood fuel (Wet)	97.7%	0.3%	97.8%	0.3%	97.7%	0.5%
Envirofit G-3300, med. pwr., wood fuel (Dry)	98.1%	0.2%	97.9%	0.4%	96.4%	0.8%
Onil, wood fuel (Dry)	98.8%	0.3%	99.2%	0.3%	97.9%	0.2%
Philips HD4012 fan, wood fuel (Dry)	99.1%	0.1%	99.8%	0.1%	99.2%	0.6%
Philips HD4012 fan, wood fuel (Wet)	98.0%	0.7%	99.2%	0.1%	98.3%	0.2%
Philips HD4008 Natural Draft, wood fuel (Dry)	94.8%	0.5%	95.3%	0.8%	95.4%	0.2%
Philips HD4008 Natural Draft, wood fuel (Wet)	97.0%	0.2%	97.7%	0.3%	97.3%	0.5%

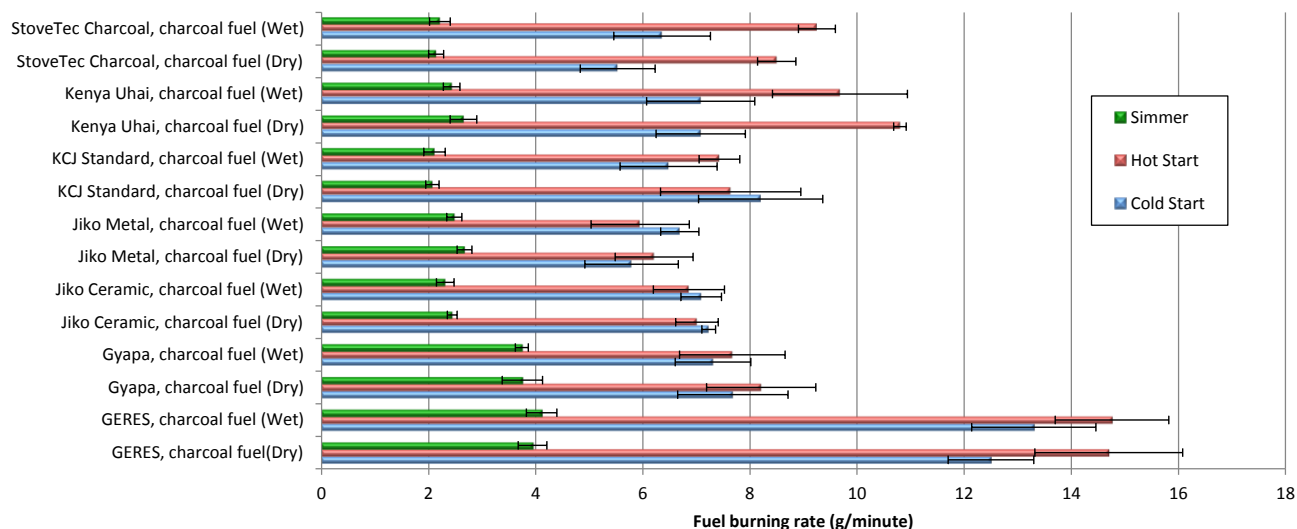
Sampada, wood fuel (Dry)	96.9%	0.3%	96.3%	0.7%	98.3%	0.2%
Sampada, wood fuel (Wet)	95.6%	0.3%	96.6%	1.0%	97.1%	1.0%
StoveTec GreenFire, wood fuel (Dry)	96.7%	0.2%	95.8%	0.4%	97.0%	0.5%
StoveTec GreenFire, wood fuel (Wet)	96.4%	0.4%	96.4%	0.7%	96.6%	0.7%
StoveTec GreenFire, med. pwr., wood fuel (Dry)	98.0%	0.3%	96.9%	0.5%	96.7%	0.5%
Upesi Portable, wood fuel (Dry)	95.7%	0.2%	96.6%	0.4%	96.4%	0.2%
Upesi Portable, wood fuel (Wet)	93.8%	0.7%	94.8%	0.5%	93.6%	0.9%
GERES, charcoal fuel(Dry)	93.3%	2.4%	88.1%	0.6%	90.3%	2.9%
GERES, charcoal fuel (Wet)	85.5%	3.4%	86.5%	5.2%	87.7%	4.5%
Gyapa, charcoal fuel (Dry)	87.4%	4.4%	79.4%	9.1%	86.4%	3.1%
Gyapa, charcoal fuel (Wet)	84.7%	1.3%	75.2%	3.0%	84.3%	1.9%
Jiko Ceramic, charcoal fuel (Dry)	87.0%	2.1%	86.1%	1.8%	90.2%	1.9%
Jiko Ceramic, charcoal fuel (Wet)	89.3%	1.0%	86.2%	2.5%	89.8%	1.4%
Jiko Metal, charcoal fuel (Dry)	87.0%	3.6%	86.9%	1.9%	92.0%	1.2%
Jiko Metal, charcoal fuel (Wet)	90.5%	1.4%	89.8%	1.4%	92.9%	0.9%
KCJ Standard, charcoal fuel (Dry)	87.2%	3.9%	80.7%	7.7%	91.7%	0.7%
KCJ Standard, charcoal fuel (Wet)	83.4%	1.6%	77.5%	5.3%	90.0%	1.7%
Kenya Uhai, charcoal fuel (Dry)	89.1%	2.5%	87.4%	1.1%	92.7%	0.7%
Kenya Uhai, charcoal fuel (Wet)	93.2%	0.6%	88.6%	6.4%	91.5%	1.9%
StoveTec Charcoal, charcoal fuel (Dry)	93.3%	0.9%	90.0%	2.8%	92.4%	2.2%
StoveTec Charcoal, charcoal fuel (Wet)	92.6%	0.5%	89.7%	1.3%	93.0%	0.3%
Belonio, rice hull fuel (Dry)	92.5%	0.4%	94.0%	1.2%	94.9%	3.4%
Belonio, rice hull fuel (Wet)	92.3%	0.4%	91.2%	2.0%	92.1%	0.9%
Mayon Turbo, rice hull fuel (Dry)	96.3%	0.2%	96.3%	0.5%	95.1%	2.6%
Mayon Turbo, rice hull fuel (Wet)	96.5%	0.1%	96.1%	0.3%	95.9%	0.1%
Oorja stove, Oorja pellet fuel (Dry)	99.2%	0.2%	99.0%	0.5%	95.0%	2.6%
Oorja stove, Oorja pellet fuel (Wet)	98.8%	0.3%	99.5%	0.3%	98.3%	
StoveTec TLUD, wood pellet fuel (Dry)	99.6%	0.1%	99.5%	0.3%	99.1%	0.4%
Jinqilin CKQ-80I, corn cob fuel (Dry)	92.3%	1.0%	93.5%	2.2%	94.6%	1.7%
Jinqilin CKQ-80I, corn cob fuel (Wet)	85.0%	1.2%	92.5%	2.7%	89.6%	4.5%
Protos, plant oil fuel	98.8%	0.2%	99.1%	0.2%	99.0%	0.5%

Figure S14. Fuel Burning Rate - Wood



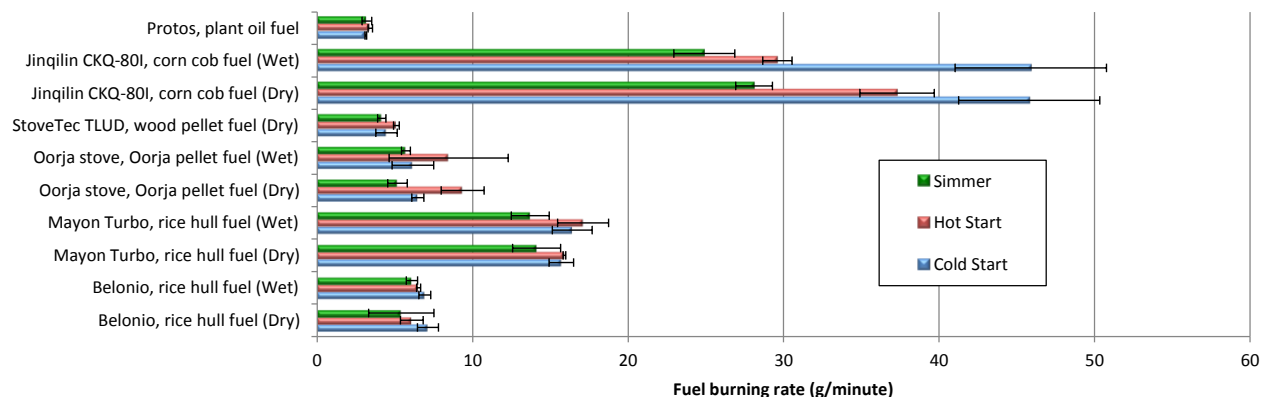
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	27.9	2.7	31.9	2.7	15.9	1.5
3 Stone carefully tended, wood fuel (Wet)	18.4	1.0	23.3	1.5	16.0	0.9
3 Stone minimally tended, wood fuel (Dry)	26.4	1.9	31.3	4.2	16.4	2.3
Berkeley Darfur, wood fuel (Dry)	9.0	0.3	10.7	1.4	7.4	0.5
Berkeley Darfur, wood fuel (Wet)	9.0	1.6	10.9	0.4	6.5	0.2
Envirofit G-3300, wood fuel (Dry)	14.7	1.6	16.5	1.9	7.3	0.8
Envirofit G-3300, wood fuel (Wet)	9.2	0.4	11.3	0.1	7.6	0.3
Envirofit G-3300, med. pwr., wood fuel (Dry)	10.0	0.9	12.7	1.0	6.3	0.2
Onil, wood fuel (Dry)	23.1	2.0	24.7	1.2	16.9	1.0
Philips HD4008 Natural Draft, wood fuel (Dry)	12.5	1.6	12.4	0.4	6.5	0.1
Philips HD4008 Natural Draft, wood fuel (Wet)	15.9	1.6	16.7	0.7	6.4	0.5
Philips HD4012 fan, wood fuel (Dry)	15.5	0.6	17.5	0.9	5.7	0.1
Philips HD4012 fan, wood fuel (Wet)	14.0	0.6	16.8	1.1	6.4	0.6
Sampada, wood fuel (Dry)	18.3	0.9	19.0	3.6	13.7	2.4
Sampada, wood fuel (Wet)	21.7	1.6	17.6	2.6	12.8	0.7
StoveTec GreenFire, wood fuel (Dry)	13.2	1.5	17.1	2.1	6.3	0.7
StoveTec GreenFire, wood fuel (Wet)	9.5	0.3	12.1	1.0	7.1	0.4
StoveTec GreenFire, med. pwr., wood fuel (Dry)	9.5	0.7	12.8	1.1	6.7	0.5
Upesi Portable, wood fuel (Dry)	18.4	1.3	18.6	0.4	15.4	1.4
Upesi Portable, wood fuel (Wet)	16.3	3.7	16.0	1.8	11.0	1.4

Figure S15. Fuel Burning Rate - Charcoal



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel(Dry)	12.5	0.8	14.7	1.4	3.9	0.3
GERES, charcoal fuel (Wet)	13.3	1.2	14.8	1.1	4.1	0.3
Gyapa, charcoal fuel (Dry)	7.7	1.0	8.2	1.0	3.8	0.4
Gyapa, charcoal fuel (Wet)	7.3	0.7	7.7	1.0	3.7	0.1
Jiko Ceramic, charcoal fuel (Dry)	7.2	0.1	7.0	0.4	2.4	0.1
Jiko Ceramic, charcoal fuel (Wet)	7.1	0.4	6.9	0.7	2.3	0.2
Jiko Metal, charcoal fuel (Dry)	5.8	0.9	6.2	0.7	2.7	0.1
Jiko Metal, charcoal fuel (Wet)	6.7	0.4	6.0	0.9	2.5	0.1
KCJ Standard, charcoal fuel (Dry)	8.2	1.2	7.6	1.3	2.1	0.1
KCJ Standard, charcoal fuel (Wet)	6.5	0.9	7.4	0.4	2.1	0.2
Kenya Uhai, charcoal fuel (Dry)	7.1	0.8	10.8	0.1	2.7	0.2
Kenya Uhai, charcoal fuel (Wet)	7.1	1.0	9.7	1.3	2.4	0.2
StoveTec Charcoal, charcoal fuel (Dry)	5.5	0.7	8.5	0.4	2.1	0.1
StoveTec Charcoal, charcoal fuel (Wet)	6.4	0.9	9.3	0.3	2.2	0.2

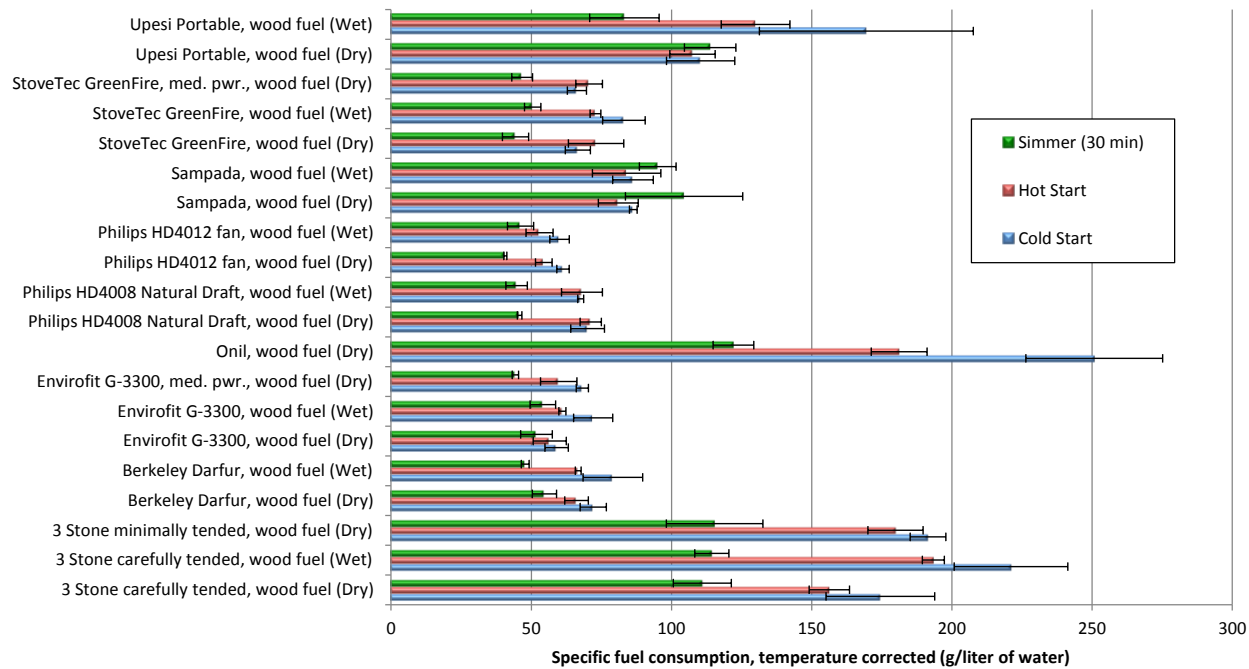
Figure S16. Fuel Burning Rate - Other Fuels



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	7.1	0.7	6.1	0.7	5.4	2.1
Belonio, rice hull fuel (Wet)	6.9	0.4	6.5	0.1	6.1	0.4
Mayon Turbo, rice hull fuel (Dry)	15.7	0.8	15.9	0.1	14.1	1.5
Mayon Turbo, rice hull fuel (Wet)	16.4	1.3	17.1	1.6	13.7	1.2

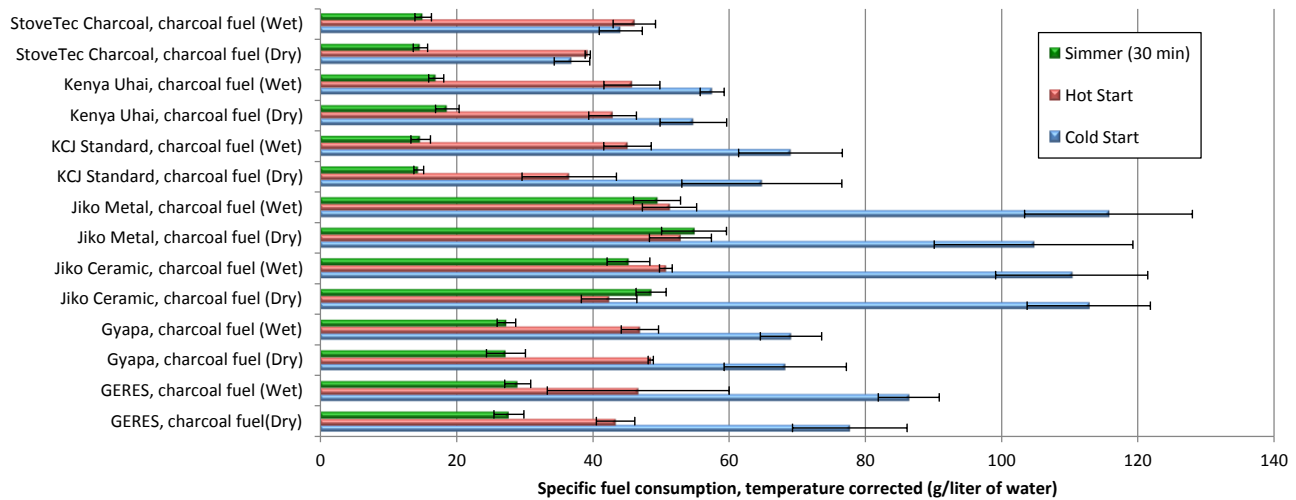
Oorja stove, Oorja pellet fuel (Dry)	6.5	0.4	9.4	1.4	5.2	0.6
Oorja stove, Oorja pellet fuel (Wet)	6.2	1.3	8.5	3.8	5.7	0.3
StoveTec TLUD, wood pellet fuel (Dry)	4.5	0.7	5.1	0.2	4.2	0.3
Jinqilin CKQ-80I, corn cob fuel (Dry)	45.8	4.5	37.3	2.4	28.1	1.2
Jinqilin CKQ-80I, corn cob fuel (Wet)	45.9	4.9	29.6	0.9	24.9	2.0
Protos, plant oil fuel	3.1	0.1	3.4	0.1	3.2	0.3

Figure S17. Specific Fuel Consumption - Wood



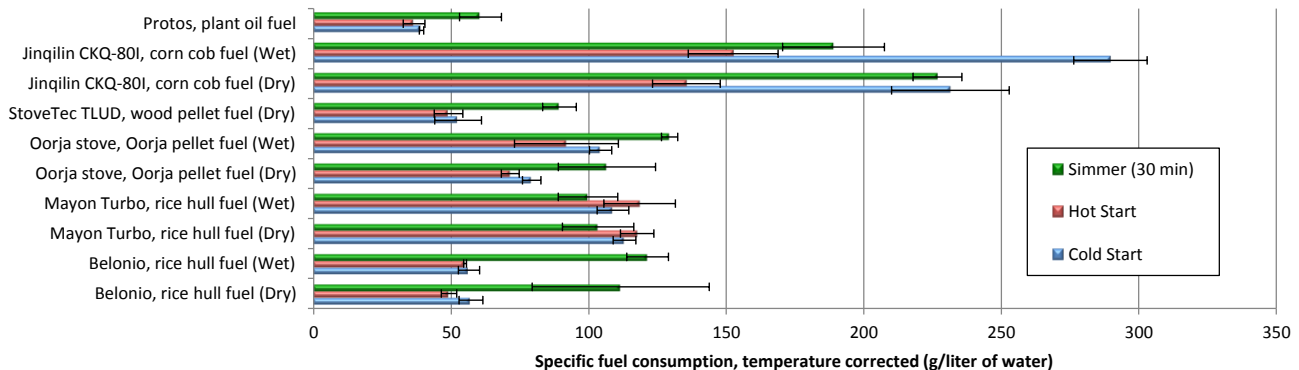
	Cold Start		Hot Start		Simmer (30 min)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	174.5	19.4	156.3	7.2	111.0	10.4
3 Stone carefully tended, wood fuel (Wet)	221.1	20.3	193.4	3.9	114.4	6.1
3 Stone minimally tended, wood fuel (Dry)	191.5	6.4	179.9	9.8	115.4	17.2
Berkeley Darfur, wood fuel (Dry)	72.1	4.7	66.1	4.2	54.7	4.3
Berkeley Darfur, wood fuel (Wet)	79.1	10.6	66.7	1.0	47.8	1.4
Envirofit G-3300, wood fuel (Dry)	59.0	4.2	56.6	5.9	51.9	5.6
Envirofit G-3300, wood fuel (Wet)	72.1	7.0	61.1	1.3	54.1	4.6
Envirofit G-3300, med. pwr., wood fuel (Dry)	68.2	2.2	59.8	6.5	44.3	1.1
Onil, wood fuel (Dry)	250.8	24.4	181.2	9.9	122.1	7.3
Philips HD4008 Natural Draft, wood fuel (Dry)	70.1	6.0	71.2	3.8	45.8	0.8
Philips HD4008 Natural Draft, wood fuel (Wet)	67.6	1.1	68.1	7.3	44.8	3.8
Philips HD4012 fan, wood fuel (Dry)	61.3	2.2	54.5	3.0	40.8	0.5
Philips HD4012 fan, wood fuel (Wet)	60.1	3.5	52.9	4.8	46.2	4.7
Sampada, wood fuel (Dry)	86.4	1.4	81.0	7.1	104.5	20.9
Sampada, wood fuel (Wet)	86.3	7.2	84.0	12.2	95.1	6.5
StoveTec GreenFire, wood fuel (Dry)	66.6	4.5	73.1	9.9	44.4	4.7
StoveTec GreenFire, wood fuel (Wet)	83.0	7.6	72.9	1.9	50.5	2.9
StoveTec GreenFire, med. pwr., wood fuel (Dry)	66.3	3.4	70.6	4.7	46.8	3.7
Upesi Portable, wood fuel (Dry)	110.4	12.2	107.5	8.1	113.8	9.2
Upesi Portable, wood fuel (Wet)	169.5	38.2	130.0	12.3	83.2	12.4

Figure S18. Specific Fuel Consumption - Charcoal



	Cold Start		Hot Start		Simmer (30 min)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel (Dry)	77.7	8.4	43.3	2.8	27.7	2.2
GERES, charcoal fuel (Wet)	86.4	4.5	46.6	13.4	29.0	1.9
Gyapa, charcoal fuel (Dry)	68.2	9.0	48.5	0.4	27.2	2.9
Gyapa, charcoal fuel (Wet)	69.1	4.5	46.9	2.7	27.3	1.4
Jiko Ceramic, charcoal fuel (Dry)	112.8	9.1	42.4	4.1	48.5	2.2
Jiko Ceramic, charcoal fuel (Wet)	110.3	11.2	50.7	0.9	45.2	3.1
Jiko Metal, charcoal fuel (Dry)	104.7	14.6	52.8	4.6	54.8	4.8
Jiko Metal, charcoal fuel (Wet)	115.7	12.3	51.2	4.0	49.4	3.4
KCJ Standard, charcoal fuel (Dry)	64.8	11.8	36.5	6.9	14.4	0.7
KCJ Standard, charcoal fuel (Wet)	69.0	7.6	45.1	3.5	14.7	1.4
Kenya Uhai, charcoal fuel (Dry)	54.7	4.9	42.9	3.5	18.6	1.7
Kenya Uhai, charcoal fuel (Wet)	57.5	1.8	45.7	4.1	17.0	1.1
StoveTec Charcoal, charcoal fuel (Dry)	36.9	2.6	39.2	0.4	14.7	1.1
StoveTec Charcoal, charcoal fuel (Wet)	44.1	3.2	46.1	3.1	15.1	1.2

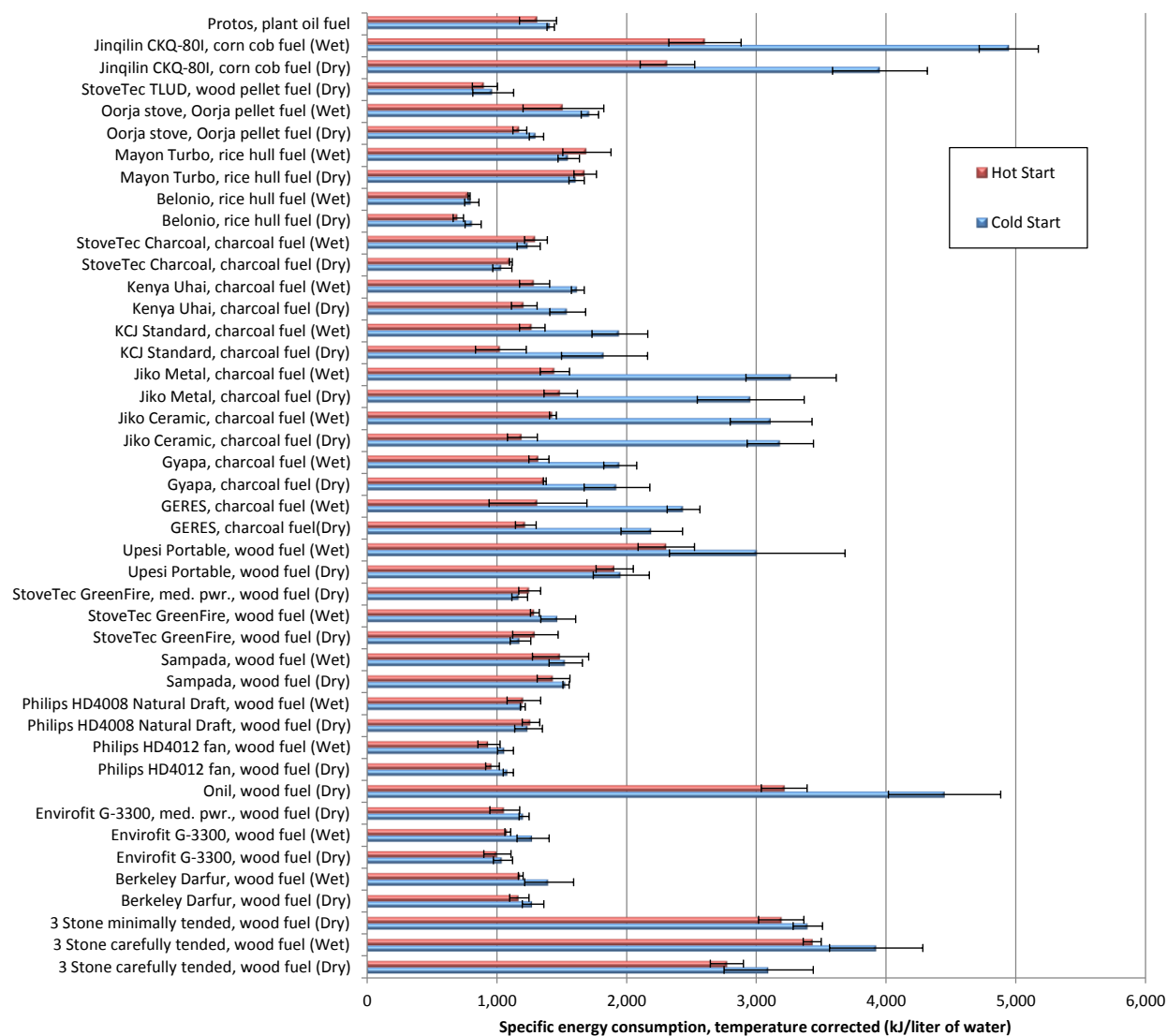
Figure S19. Specific Fuel Consumption - Other Fuels



	Cold Start		Hot Start		Simmer (30 min)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	57.2	4.3	49.2	2.8	111.6	32.2
Belonio, rice hull fuel (Wet)	56.4	3.9	55.0	0.5	121.4	7.6
Mayon Turbo, rice hull fuel (Dry)	113.0	4.1	117.6	6.1	103.4	13.0
Mayon Turbo, rice hull fuel (Wet)	108.8	5.8	118.5	13.0	99.7	10.8
Oorja stove, Oorja pellet fuel (Dry)	79.3	3.4	71.5	3.2	106.6	17.7
Oorja stove, Oorja pellet fuel (Wet)	104.3	4.0	91.9	18.9	129.4	3.0

StoveTec TLUD, wood pellet fuel (Dry)	52.5	8.5	49.0	5.2	89.4	6.1
Jinqilin CKQ-80I, corn cob fuel (Dry)	231.5	21.4	135.5	12.3	226.8	8.9
Jinqilin CKQ-80I, corn cob fuel (Wet)	289.7	13.3	152.5	16.3	189.0	18.5
Protos, plant oil fuel	39.2	0.8	36.5	3.9	60.6	7.6

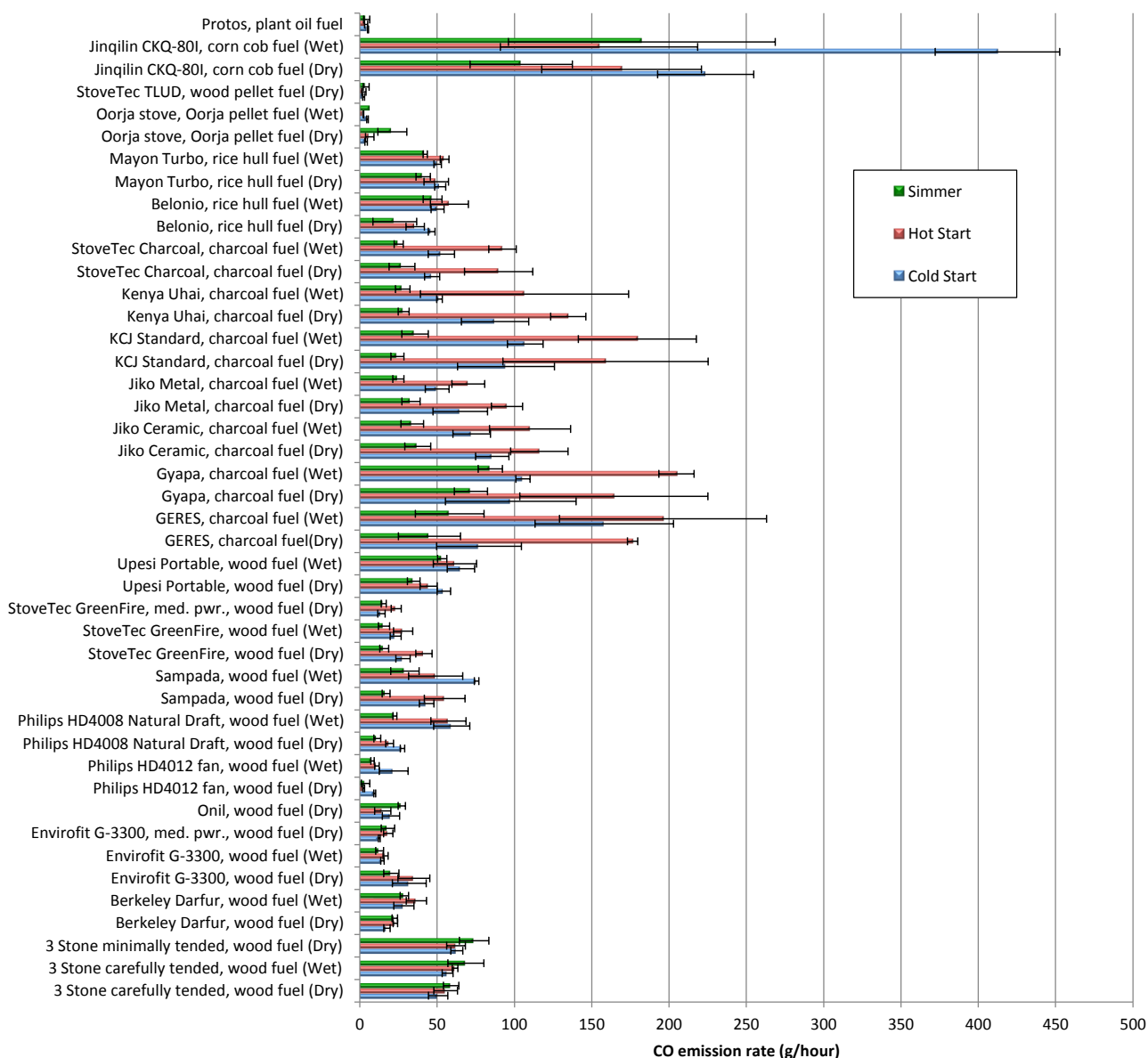
Figure S20. Specific Energy Consumption - High Power



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	3,095	344	2,773	128
3 Stone carefully tended, wood fuel (Wet)	3,924	360	3,431	70
3 Stone minimally tended, wood fuel (Dry)	3,397	113	3,192	174
Berkeley Darfur, wood fuel (Dry)	1,279	83	1,173	75
Berkeley Darfur, wood fuel (Wet)	1,403	189	1,184	18
Envirofit G-3300, wood fuel (Dry)	1,047	74	1,004	105
Envirofit G-3300, wood fuel (Wet)	1,279	124	1,084	22
Envirofit G-3300, med. pwr., wood fuel (Dry)	1,210	39	1,061	115
Onil, wood fuel (Dry)	4,451	433	3,215	177
Philips HD4012 fan, wood fuel (Dry)	1,088	39	966	52
Philips HD4012 fan, wood fuel (Wet)	1,066	61	939	86
Philips HD4008 Natural Draft, wood fuel (Dry)	1,244	107	1,263	67
Philips HD4008 Natural Draft, wood fuel (Wet)	1,200	19	1,208	129
Sampada, wood fuel (Dry)	1,533	24	1,437	126

Sampada, wood fuel (Wet)	1,531	129	1,491	217
StoveTec GreenFire, wood fuel (Dry)	1,182	79	1,297	175
StoveTec GreenFire, wood fuel (Wet)	1,473	135	1,293	34
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1,176	61	1,253	84
Upesi Portable, wood fuel (Dry)	1,959	216	1,908	143
Upesi Portable, wood fuel (Wet)	3,007	677	2,306	217
GERES, charcoal fuel(Dry)	2,194	238	1,223	80
GERES, charcoal fuel (Wet)	2,439	126	1,317	377
Gyapa, charcoal fuel (Dry)	1,926	254	1,369	11
Gyapa, charcoal fuel (Wet)	1,951	127	1,324	77
Jiko Ceramic, charcoal fuel (Dry)	3,185	256	1,197	115
Jiko Ceramic, charcoal fuel (Wet)	3,114	315	1,432	26
Jiko Metal, charcoal fuel (Dry)	2,957	412	1,492	129
Jiko Metal, charcoal fuel (Wet)	3,268	348	1,447	113
KCJ Standard, charcoal fuel (Dry)	1,830	332	1,031	196
KCJ Standard, charcoal fuel (Wet)	1,948	215	1,273	98
Kenya Uhai, charcoal fuel (Dry)	1,546	138	1,211	99
Kenya Uhai, charcoal fuel (Wet)	1,624	50	1,291	116
StoveTec Charcoal, charcoal fuel (Dry)	1,042	74	1,108	11
StoveTec Charcoal, charcoal fuel (Wet)	1,245	89	1,301	88
Belonio, rice hull fuel (Dry)	817	62	703	40
Belonio, rice hull fuel (Wet)	807	55	786	7
Mayon Turbo, rice hull fuel (Dry)	1,615	59	1,681	87
Mayon Turbo, rice hull fuel (Wet)	1,554	82	1,694	186
Oorja stove, Oorja pellet fuel (Dry)	1,305	55	1,177	54
Oorja stove, Oorja pellet fuel (Wet)	1,717	67	1,513	311
StoveTec TLUD, wood pellet fuel (Dry)	972	157	907	96
Jinqilin CKQ-80I, corn cob fuel (Dry)	3,953	365	2,315	210
Jinqilin CKQ-80I, corn cob fuel (Wet)	4,946	228	2,604	279
Protos, plant oil fuel	1,415	29	1,317	143

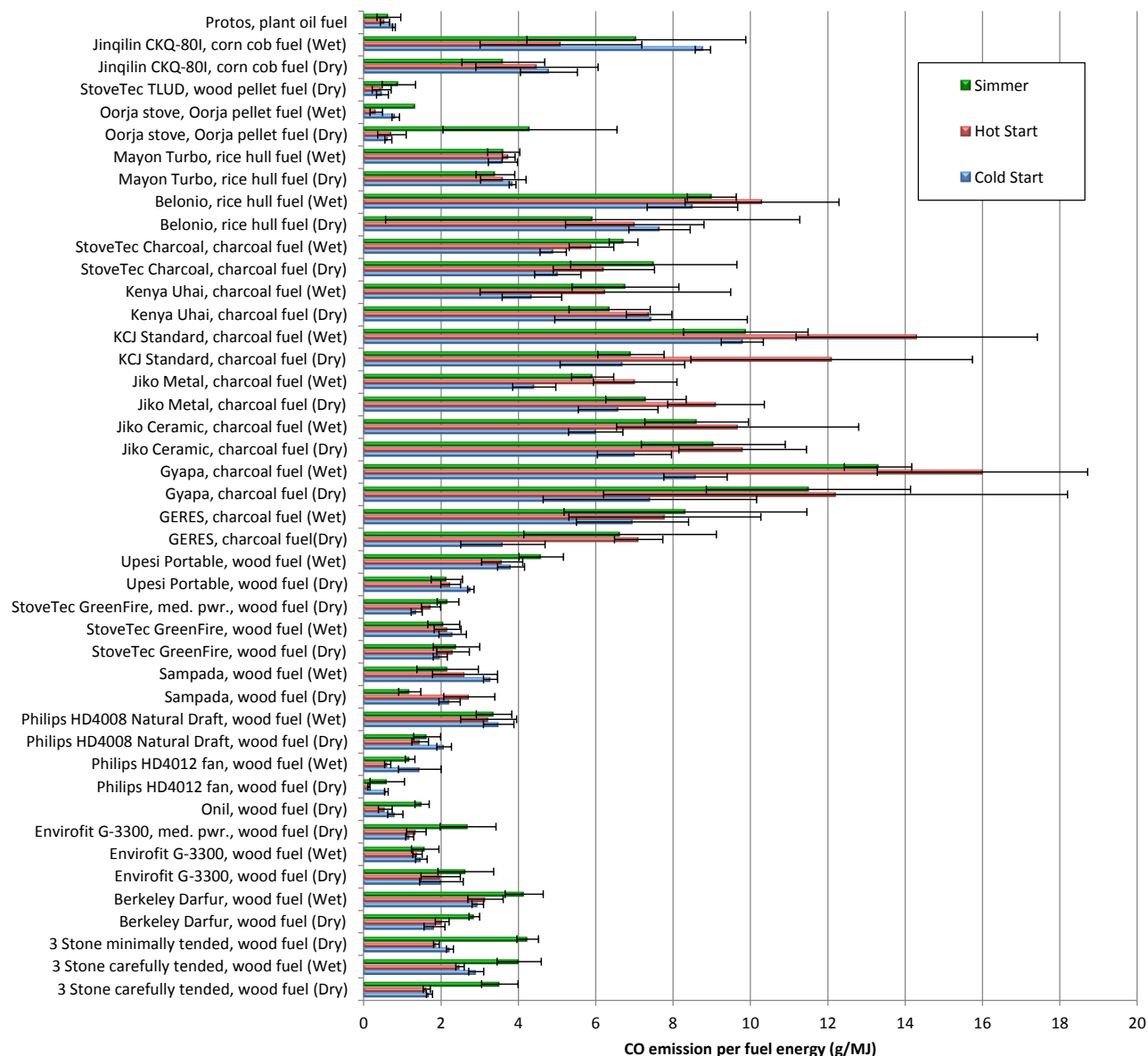
Figure S21. CO Emission Rate (per Time)



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	50.6	6.3	55.5	7.7	59.1	5.0
3 Stone carefully tended, wood fuel (Wet)	56.8	3.5	61.6	1.8	68.6	11.6
3 Stone minimally tended, wood fuel (Dry)	62.7	3.9	62.2	6.1	73.9	9.5
Berkeley Darfur, wood fuel (Dry)	17.6	2.0	23.0	1.4	22.6	1.8
Berkeley Darfur, wood fuel (Wet)	28.5	6.5	36.6	6.6	28.8	2.7
Envirofit G-3300, wood fuel (Dry)	32.0	10.9	35.0	10.3	20.4	4.9
Envirofit G-3300, wood fuel (Wet)	14.6	1.1	16.7	1.6	12.8	2.5
Envirofit G-3300, med. pwr., wood fuel (Dry)	12.6	0.6	18.4	3.0	18.1	4.3
Onil, wood fuel (Dry)	20.1	5.6	14.8	5.3	27.1	2.4
Philips HD4012 fan, wood fuel (Dry)	9.7	0.6	2.5	0.5	3.7	2.7
Philips HD4012 fan, wood fuel (Wet)	21.9	9.3	11.1	1.4	8.2	1.1
Philips HD4008 Natural Draft, wood fuel (Dry)	27.6	1.4	19.3	2.5	11.3	2.2
Philips HD4008 Natural Draft, wood fuel (Wet)	59.4	11.7	57.3	11.4	22.7	1.3
Sampada, wood fuel (Dry)	43.2	4.7	54.9	13.2	17.0	2.6

Sampada, wood fuel (Wet)	75.5	1.5	49.1	17.5	29.2	9.2
StoveTec GreenFire, wood fuel (Dry)	27.9	4.6	41.5	5.2	15.8	2.9
StoveTec GreenFire, wood fuel (Wet)	23.2	3.5	28.0	6.2	15.7	3.6
StoveTec GreenFire, med. pwr., wood fuel (Dry)	14.0	2.4	23.5	3.3	15.5	1.6
Upesi Portable, wood fuel (Dry)	54.4	4.4	44.5	5.6	34.8	4.1
Upesi Portable, wood fuel (Wet)	65.4	8.9	61.5	14.0	53.3	3.0
GERES, charcoal fuel(Dry)	77.1	27.4	176.4	3.3	45.0	20.1
GERES, charcoal fuel (Wet)	158.1	44.8	196.1	67.0	58.1	22.2
Gyapa, charcoal fuel (Dry)	97.6	42.3	164.3	60.8	71.8	10.7
Gyapa, charcoal fuel (Wet)	105.5	4.6	204.8	11.4	84.4	7.8
Jiko Ceramic, charcoal fuel (Dry)	85.7	10.8	116.1	18.6	37.5	8.4
Jiko Ceramic, charcoal fuel (Wet)	72.4	12.1	110.1	26.2	33.9	7.3
Jiko Metal, charcoal fuel (Dry)	65.0	17.6	95.2	10.1	33.1	5.9
Jiko Metal, charcoal fuel (Wet)	50.0	7.7	70.2	10.6	24.9	3.6
KCJ Standard, charcoal fuel (Dry)	94.5	31.3	158.9	66.4	24.3	4.2
KCJ Standard, charcoal fuel (Wet)	107.0	11.5	179.5	38.2	35.7	8.6
Kenya Uhai, charcoal fuel (Dry)	87.5	21.8	134.8	11.4	28.3	3.5
Kenya Uhai, charcoal fuel (Wet)	51.5	1.8	106.5	67.4	27.7	4.7
StoveTec Charcoal, charcoal fuel (Dry)	46.8	4.9	89.8	22.1	27.3	8.3
StoveTec Charcoal, charcoal fuel (Wet)	52.7	8.5	92.3	8.9	25.2	2.9
Belonio, rice hull fuel (Dry)	46.5	2.2	35.8	5.9	22.6	14.2
Belonio, rice hull fuel (Wet)	50.3	4.2	57.9	12.3	47.1	6.1
Mayon Turbo, rice hull fuel (Dry)	52.0	3.6	49.4	7.9	41.0	4.6
Mayon Turbo, rice hull fuel (Wet)	50.3	2.4	54.8	2.8	42.3	1.4
Oorja stove, Oorja pellet fuel (Dry)	4.1	0.8	6.4	2.7	21.0	9.4
Oorja stove, Oorja pellet fuel (Wet)	5.0	0.5	2.4	0.1	7.3	
StoveTec TLUD, wood pellet fuel (Dry)	2.4	0.6	2.6	1.4	4.1	1.9
Jinqilin CKQ-80I, corn cob fuel (Dry)	223.7	31.1	169.3	51.7	104.4	33.1
Jinqilin CKQ-80I, corn cob fuel (Wet)	412.4	40.3	154.7	63.8	182.4	86.3
Protos, plant oil fuel	5.3	0.3	4.1	1.0	4.4	2.0

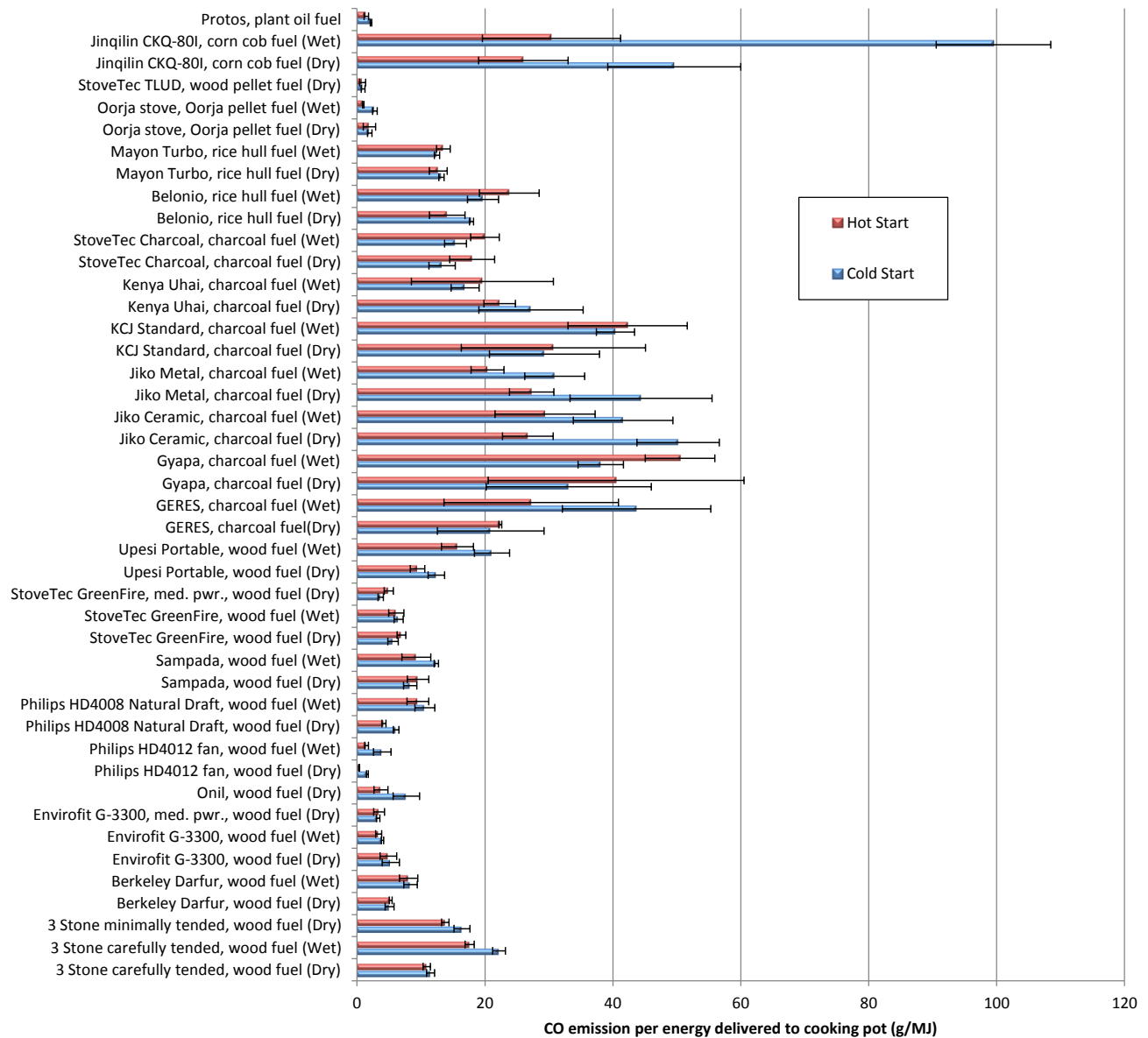
Figure S22. CO Emission per Fuel Energy



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1.7	0.1	1.6	0.1	3.5	0.5
3 Stone carefully tended, wood fuel (Wet)	2.9	0.2	2.5	0.1	4.0	0.6
3 Stone minimally tended, wood fuel (Dry)	2.2	0.1	1.9	0.1	4.2	0.3
Berkeley Darfur, wood fuel (Dry)	1.8	0.3	2.0	0.2	2.9	0.1
Berkeley Darfur, wood fuel (Wet)	3.0	0.1	3.2	0.5	4.2	0.5
Envirofit G-3300, wood fuel (Dry)	2.0	0.6	2.0	0.5	2.6	0.7
Envirofit G-3300, wood fuel (Wet)	1.5	0.2	1.4	0.1	1.6	0.4
Envirofit G-3300, med. pwr., wood fuel (Dry)	1.2	0.1	1.4	0.3	2.7	0.7
Onil, wood fuel (Dry)	0.8	0.2	0.6	0.2	1.5	0.2
Philips HD4012 fan, wood fuel (Dry)	0.6	0.0	0.1	0.0	0.6	0.4
Philips HD4012 fan, wood fuel (Wet)	1.5	0.6	0.6	0.1	1.2	0.1
Philips HD4008 Natural Draft, wood fuel (Dry)	2.1	0.2	1.5	0.2	1.6	0.3
Philips HD4008 Natural Draft, wood fuel (Wet)	3.5	0.4	3.2	0.7	3.4	0.5
Sampada, wood fuel (Dry)	2.2	0.3	2.7	0.7	1.2	0.3
Sampada, wood fuel (Wet)	3.3	0.2	2.6	0.8	2.2	0.8

StoveTec GreenFire, wood fuel (Dry)	2.0	0.2	2.3	0.4	2.4	0.6
StoveTec GreenFire, wood fuel (Wet)	2.3	0.4	2.2	0.3	2.1	0.4
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1.4	0.1	1.7	0.2	2.2	0.3
Upesi Portable, wood fuel (Dry)	2.8	0.1	2.3	0.3	2.2	0.4
Upesi Portable, wood fuel (Wet)	3.8	0.3	3.6	0.5	4.6	0.6
GERES, charcoal fuel(Dry)	3.6	1.1	7.1	0.6	6.6	2.5
GERES, charcoal fuel (Wet)	7.0	1.5	7.8	2.5	8.3	3.1
Gyapa, charcoal fuel (Dry)	7.4	2.8	12.2	6.0	11.5	2.6
Gyapa, charcoal fuel (Wet)	8.6	0.8	16.0	2.7	13.3	0.9
Jiko Ceramic, charcoal fuel (Dry)	7.0	1.0	9.8	1.7	9.0	1.9
Jiko Ceramic, charcoal fuel (Wet)	6.0	0.7	9.7	3.1	8.6	1.3
Jiko Metal, charcoal fuel (Dry)	6.6	1.0	9.1	1.3	7.3	1.0
Jiko Metal, charcoal fuel (Wet)	4.4	0.6	7.0	1.1	5.9	0.5
KCJ Standard, charcoal fuel (Dry)	6.7	1.6	12.1	3.6	6.9	0.9
KCJ Standard, charcoal fuel (Wet)	9.8	0.5	14.3	3.1	9.9	1.6
Kenya Uhai, charcoal fuel (Dry)	7.4	2.5	7.4	0.6	6.4	1.1
Kenya Uhai, charcoal fuel (Wet)	4.4	0.8	6.3	3.2	6.8	1.4
StoveTec Charcoal, charcoal fuel (Dry)	5.0	0.6	6.2	1.3	7.5	2.2
StoveTec Charcoal, charcoal fuel (Wet)	4.9	0.3	5.9	0.6	6.7	0.4
Belonio, rice hull fuel (Dry)	7.7	0.8	7.0	1.8	5.9	5.4
Belonio, rice hull fuel (Wet)	8.5	1.2	10.3	2.0	9.0	0.6
Mayon Turbo, rice hull fuel (Dry)	3.9	0.1	3.6	0.6	3.4	0.5
Mayon Turbo, rice hull fuel (Wet)	3.6	0.4	3.8	0.2	3.6	0.4
Oorja stove, Oorja pellet fuel (Dry)	0.6	0.1	0.7	0.4	4.3	2.3
Oorja stove, Oorja pellet fuel (Wet)	0.8	0.1	0.3	0.2	1.3	
StoveTec TLUD, wood pellet fuel (Dry)	0.5	0.2	0.5	0.2	0.9	0.4
Jinqilin CKQ-80l, corn cob fuel (Dry)	4.8	0.7	4.5	1.6	3.6	1.1
Jinqilin CKQ-80l, corn cob fuel (Wet)	8.8	0.2	5.1	2.1	7.1	2.8
Protos, plant oil fuel	0.8	0.0	0.6	0.1	0.7	0.3

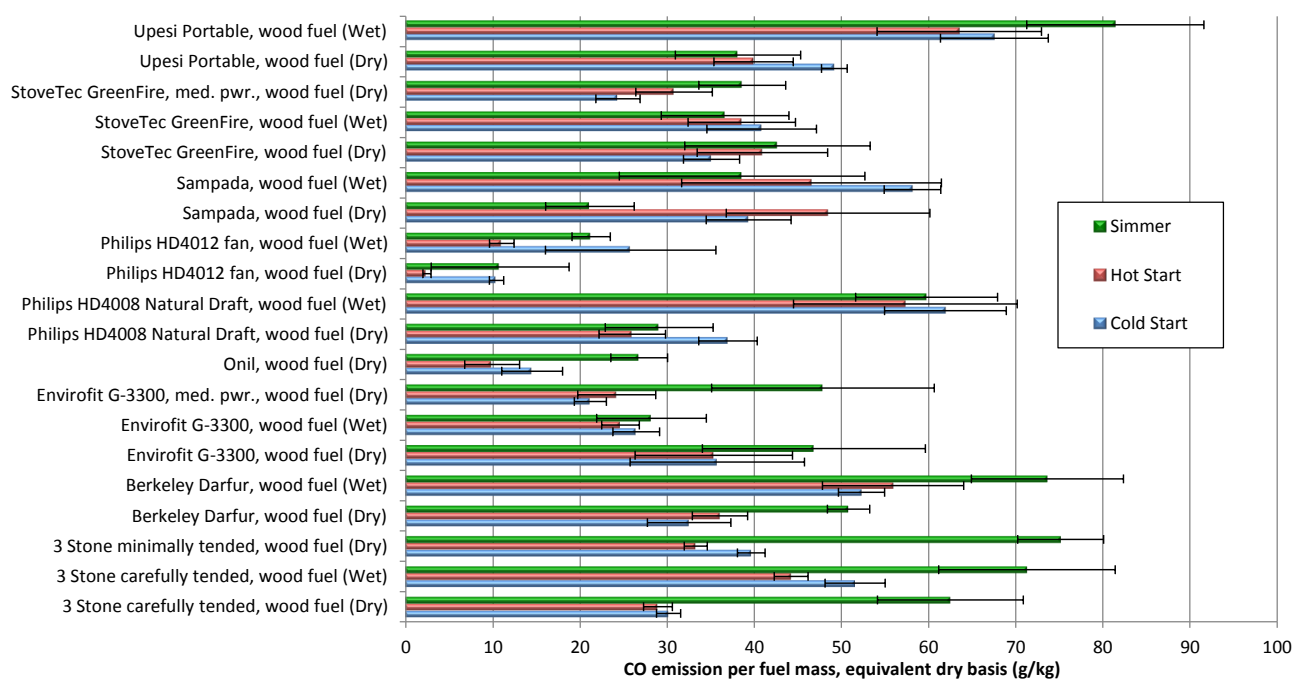
Figure S23. CO Emission per Energy Delivered to Cooking Pot



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	11.5	0.6	10.9	0.6
3 Stone carefully tended, wood fuel (Wet)	22.2	1.0	17.6	0.7
3 Stone minimally tended, wood fuel (Dry)	16.4	1.3	13.8	0.6
Berkeley Darfur, wood fuel (Dry)	5.1	0.7	5.3	0.2
Berkeley Darfur, wood fuel (Wet)	8.4	1.1	8.1	1.4
Envirofit G-3300, wood fuel (Dry)	5.3	1.4	4.9	1.3
Envirofit G-3300, wood fuel (Wet)	4.0	0.2	3.4	0.5
Envirofit G-3300, med. pwr., wood fuel (Dry)	3.3	0.3	3.5	0.9
Onil, wood fuel (Dry)	7.7	2.1	3.7	1.1
Philips HD4012 fan, wood fuel (Dry)	1.6	0.1	0.3	0.1
Philips HD4012 fan, wood fuel (Wet)	3.9	1.4	1.5	0.3
Philips HD4008 Natural Draft, wood fuel (Dry)	6.1	0.4	4.2	0.3
Philips HD4008 Natural Draft, wood fuel (Wet)	10.6	1.6	9.5	1.7
Sampada, wood fuel (Dry)	8.3	1.0	9.5	1.7
Sampada, wood fuel (Wet)	12.4	0.3	9.3	2.3

StoveTec GreenFire, wood fuel (Dry)	5.6	0.8	6.9	0.7
StoveTec GreenFire, wood fuel (Wet)	6.5	0.7	6.1	1.2
StoveTec GreenFire, med. pwr., wood fuel (Dry)	3.7	0.4	5.0	0.7
Upesi Portable, wood fuel (Dry)	12.4	1.3	9.5	1.1
Upesi Portable, wood fuel (Wet)	21.1	2.8	15.7	2.5
GERES, charcoal fuel(Dry)	20.9	8.3	22.4	0.2
GERES, charcoal fuel (Wet)	43.7	11.6	27.2	13.6
Gyapa, charcoal fuel (Dry)	33.1	12.9	40.5	20.0
Gyapa, charcoal fuel (Wet)	38.1	3.6	50.5	5.4
Jiko Ceramic, charcoal fuel (Dry)	50.2	6.4	26.7	4.0
Jiko Ceramic, charcoal fuel (Wet)	41.6	7.8	29.4	7.8
Jiko Metal, charcoal fuel (Dry)	44.4	11.1	27.3	3.5
Jiko Metal, charcoal fuel (Wet)	30.9	4.7	20.4	2.6
KCJ Standard, charcoal fuel (Dry)	29.3	8.6	30.7	14.4
KCJ Standard, charcoal fuel (Wet)	40.4	3.0	42.3	9.3
Kenya Uhai, charcoal fuel (Dry)	27.2	8.2	22.3	2.5
Kenya Uhai, charcoal fuel (Wet)	16.9	2.2	19.6	11.1
StoveTec Charcoal, charcoal fuel (Dry)	13.3	2.1	18.0	3.5
StoveTec Charcoal, charcoal fuel (Wet)	15.4	1.7	20.0	2.2
Belonio, rice hull fuel (Dry)	17.9	0.3	14.1	2.8
Belonio, rice hull fuel (Wet)	19.7	2.4	23.8	4.7
Mayon Turbo, rice hull fuel (Dry)	13.2	0.4	12.7	1.4
Mayon Turbo, rice hull fuel (Wet)	12.5	0.4	13.5	1.1
Oorja stove, Oorja pellet fuel (Dry)	2.0	0.3	1.9	1.0
Oorja stove, Oorja pellet fuel (Wet)	2.8	0.4	1.0	0.1
StoveTec TLUD, wood pellet fuel (Dry)	0.9	0.3	0.9	0.5
Jinqilin CKQ-80l, corn cob fuel (Dry)	49.6	10.4	26.0	7.0
Jinqilin CKQ-80l, corn cob fuel (Wet)	99.5	9.0	30.4	10.8
Protos, plant oil fuel	2.2	0.1	1.5	0.3

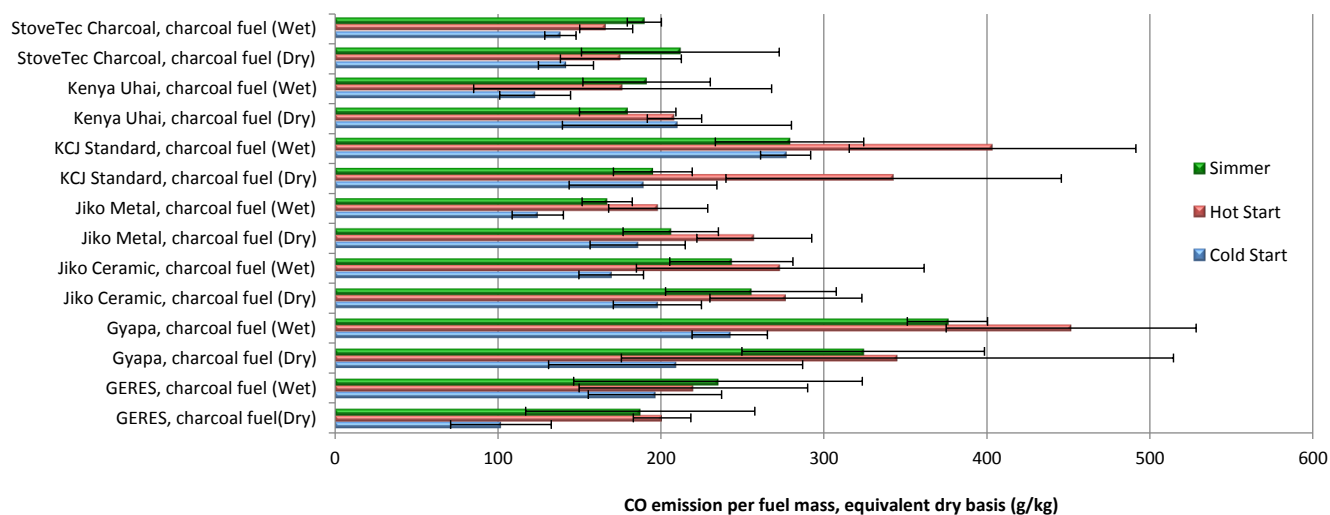
Figure S24. CO Emission per Fuel Mass (Equivalent Dry Basis)
Wood Fuel



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	30.2	1.4	28.9	1.7	62.5	8.4
3 Stone carefully tended, wood fuel (Wet)	51.6	3.5	44.2	1.9	71.3	10.1
3 Stone minimally tended, wood fuel (Dry)	39.6	1.6	33.3	1.3	75.2	4.9

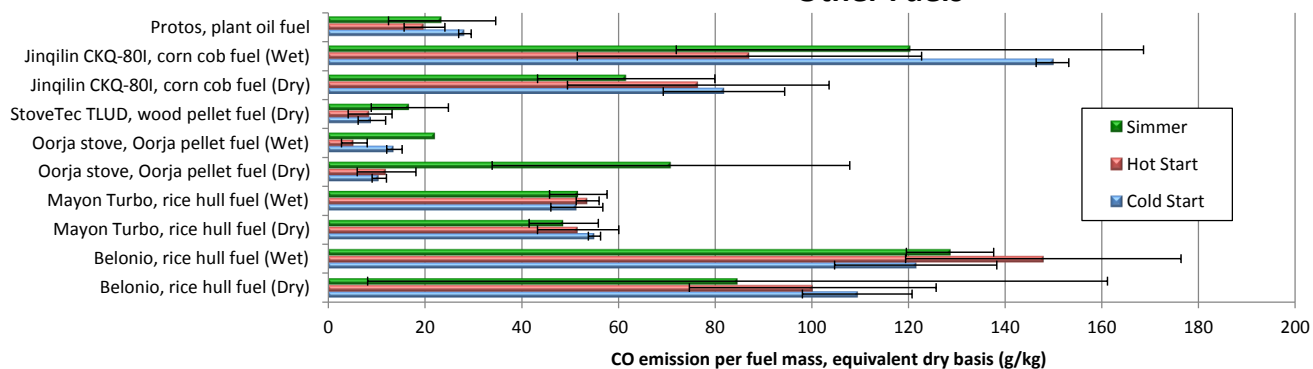
Berkeley Darfur, wood fuel (Dry)	32.5	4.8	36.1	3.2	50.8	2.4
Berkeley Darfur, wood fuel (Wet)	52.3	2.7	55.9	8.1	73.6	8.7
Envirofit G-3300, wood fuel (Dry)	35.7	10.0	35.3	9.0	46.8	12.8
Envirofit G-3300, wood fuel (Wet)	26.4	2.7	24.6	2.2	28.2	6.3
Envirofit G-3300, med. pwr., wood fuel (Dry)	21.2	1.8	24.2	4.5	47.9	12.8
Onil, wood fuel (Dry)	14.5	3.5	9.9	3.2	26.8	3.3
Philips HD4008 Natural Draft, wood fuel (Dry)	37.0	3.4	26.0	3.8	29.1	6.2
Philips HD4008 Natural Draft, wood fuel (Wet)	61.9	7.0	57.3	12.8	59.8	8.1
Philips HD4012 fan, wood fuel (Dry)	10.4	0.8	2.4	0.5	10.8	7.9
Philips HD4012 fan, wood fuel (Wet)	25.8	9.8	11.0	1.4	21.3	2.2
Sampada, wood fuel (Dry)	39.3	4.9	48.5	11.7	21.1	5.1
Sampada, wood fuel (Wet)	58.2	3.2	46.6	14.9	38.6	14.1
StoveTec GreenFire, wood fuel (Dry)	35.1	3.2	40.9	7.5	42.7	10.6
StoveTec GreenFire, wood fuel (Wet)	40.8	6.3	38.6	6.2	36.6	7.3
StoveTec GreenFire, med. pwr., wood fuel (Dry)	24.3	2.5	30.8	4.4	38.6	5.0
Upesi Portable, wood fuel (Dry)	49.2	1.5	39.9	4.6	38.1	7.2
Upesi Portable, wood fuel (Wet)	67.6	6.2	63.5	9.4	81.4	10.2

Figure S25. CO Emission per Fuel Mass (Equivalent Dry Basis)
Charcoal Fuel



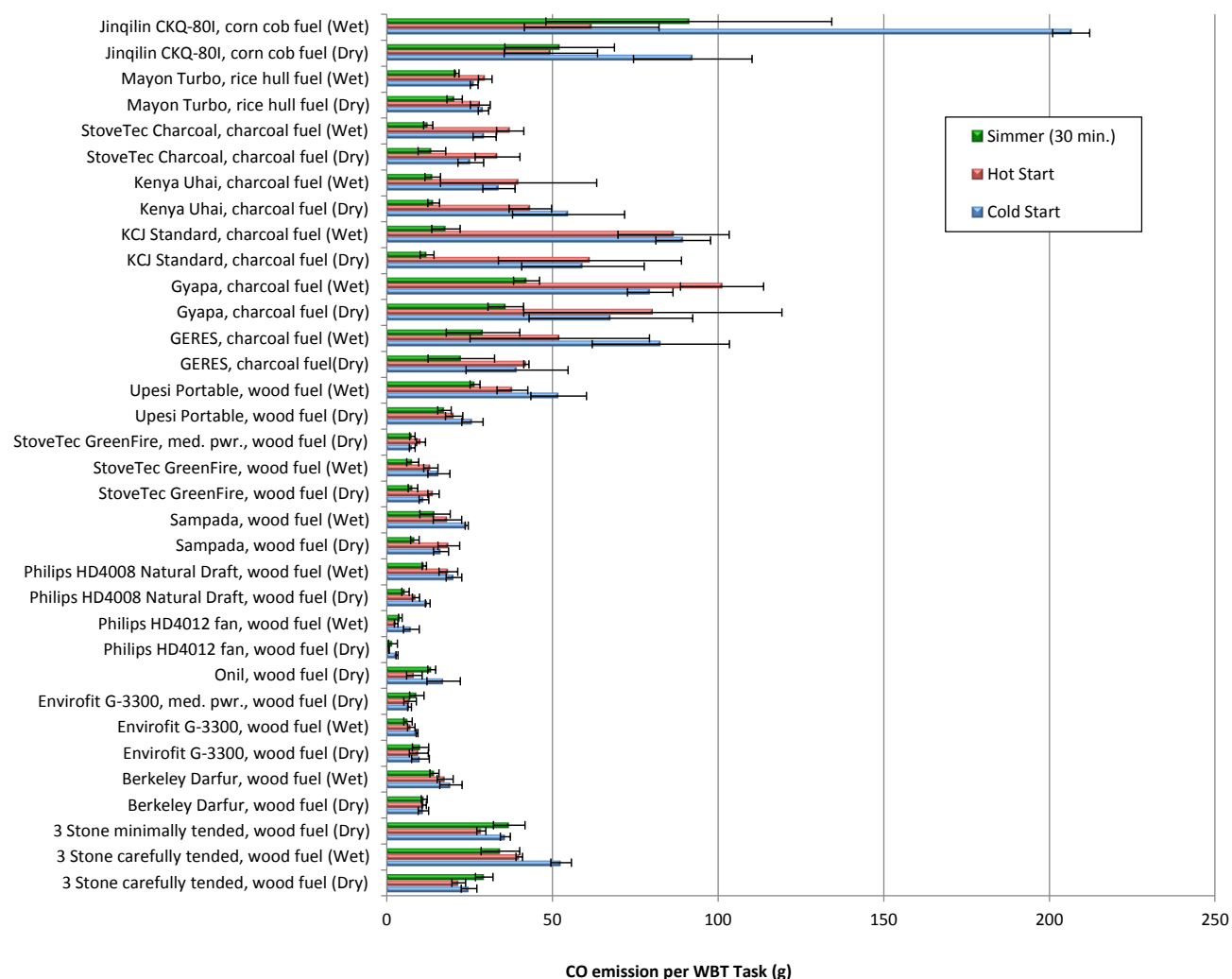
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel(Dry)	101.8	30.9	200.7	17.7	187.3	70.3
GERES, charcoal fuel (Wet)	196.3	40.9	219.9	70.1	235.0	88.6
Gyapa, charcoal fuel (Dry)	209.0	78.0	345.1	169.4	324.1	74.4
Gyapa, charcoal fuel (Wet)	242.2	23.1	451.7	76.7	375.8	24.6
Jiko Ceramic, charcoal fuel (Dry)	197.8	27.0	276.7	46.6	255.2	52.4
Jiko Ceramic, charcoal fuel (Wet)	169.5	19.8	273.2	88.3	243.2	37.8
Jiko Metal, charcoal fuel (Dry)	185.7	29.2	257.3	35.2	206.0	29.3
Jiko Metal, charcoal fuel (Wet)	124.4	15.7	198.3	30.4	167.0	15.4
KCJ Standard, charcoal fuel (Dry)	189.0	45.4	342.8	102.9	195.0	24.2
KCJ Standard, charcoal fuel (Wet)	276.5	15.4	403.5	88.0	278.9	45.5
Kenya Uhai, charcoal fuel (Dry)	209.8	70.3	208.3	16.7	179.6	29.6
Kenya Uhai, charcoal fuel (Wet)	122.8	21.7	176.5	91.4	191.2	39.1
StoveTec Charcoal, charcoal fuel (Dry)	141.7	16.9	175.4	37.1	211.9	60.7
StoveTec Charcoal, charcoal fuel (Wet)	138.3	9.6	166.4	16.3	189.8	10.5

Figure S26. CO Emission per Fuel Mass (Equivalent Dry Basis)
Other Fuels



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	109.4	11.3	100.2	25.5	84.6	76.5
Belonio, rice hull fuel (Wet)	121.5	16.8	147.9	28.5	128.6	9.0
Mayon Turbo, rice hull fuel (Dry)	55.0	1.3	51.7	8.4	48.7	7.2
Mayon Turbo, rice hull fuel (Wet)	51.4	5.4	53.6	2.4	51.7	5.9
Oorja stove, Oorja pellet fuel (Dry)	10.5	1.5	12.0	6.1	70.9	37.0
Oorja stove, Oorja pellet fuel (Wet)	13.6	1.6	5.4	2.7	22.2	
StoveTec TLUD, wood pellet fuel (Dry)	9.0	2.8	8.6	4.5	16.8	8.0
Jinqilin CKQ-80I, corn cob fuel (Dry)	81.8	12.6	76.5	27.1	61.6	18.4
Jinqilin CKQ-80I, corn cob fuel (Wet)	149.8	3.4	87.1	35.6	120.3	48.3
Protos, plant oil fuel	28.2	1.3	19.9	4.2	23.5	11.1

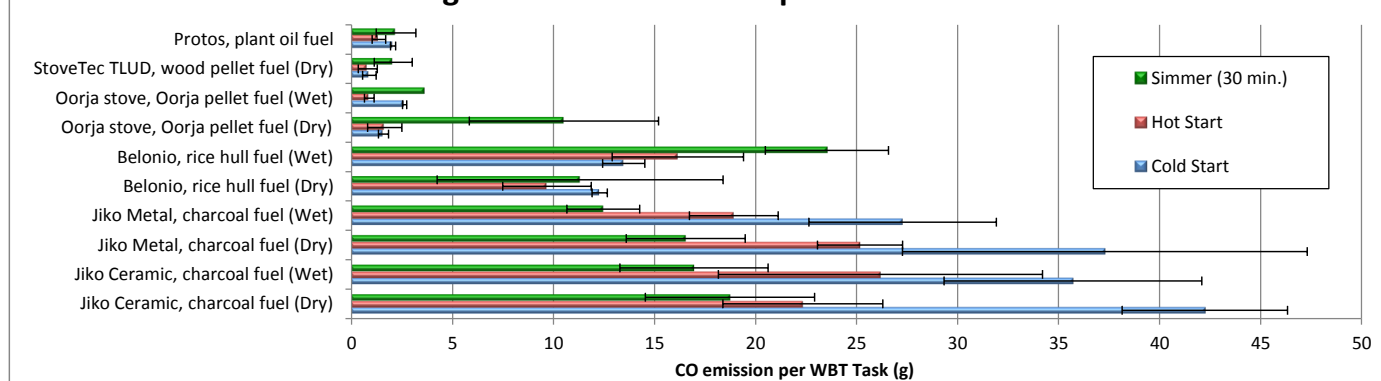
Figure S27. CO Emission per WBT Task - 5 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	24.8	2.4	21.7	2.1	29.4	2.6
3 Stone carefully tended, wood fuel (Wet)	52.6	3.1	40.0	1.0	34.3	5.8
3 Stone minimally tended, wood fuel (Dry)	35.8	1.5	28.6	1.4	37.0	4.8
Berkeley Darfur, wood fuel (Dry)	11.1	1.6	11.3	0.6	11.3	0.9
Berkeley Darfur, wood fuel (Wet)	19.4	3.4	17.6	2.4	14.4	1.4
Envirofit G-3300, wood fuel (Dry)	10.2	2.7	9.7	2.9	10.2	2.5
Envirofit G-3300, wood fuel (Wet)	9.2	0.3	7.4	1.1	6.4	1.3
Envirofit G-3300, med. pwr., wood fuel (Dry)	6.9	0.6	7.0	1.9	9.1	2.2
Onil, wood fuel (Dry)	17.2	5.0	8.3	2.4	13.6	1.2
Philips HD4012 fan, wood fuel (Dry)	3.1	0.3	0.6	0.1	1.9	1.3
Philips HD4012 fan, wood fuel (Wet)	7.4	2.4	2.8	0.5	4.1	0.5
Philips HD4008 Natural Draft, wood fuel (Dry)	12.4	0.7	8.8	1.1	5.7	1.1
Philips HD4008 Natural Draft, wood fuel (Wet)	20.3	2.4	18.6	2.8	11.3	0.6
Sampada, wood fuel (Dry)	16.4	2.3	18.7	3.3	8.5	1.3
Sampada, wood fuel (Wet)	24.1	0.5	18.3	4.3	14.6	4.6
StoveTec GreenFire, wood fuel (Dry)	11.2	1.5	14.1	1.7	7.9	1.4
StoveTec GreenFire, wood fuel (Wet)	15.7	3.3	13.3	2.2	7.8	1.8
StoveTec GreenFire, med. pwr., wood fuel (Dry)	7.7	0.9	10.3	1.3	7.7	0.8
Upesi Portable, wood fuel (Dry)	25.9	3.2	20.3	2.6	17.4	2.0
Upesi Portable, wood fuel (Wet)	51.9	8.4	37.9	4.6	26.7	1.5
GERES, charcoal fuel(Dry)	39.3	15.4	42.1	0.8	22.5	10.0

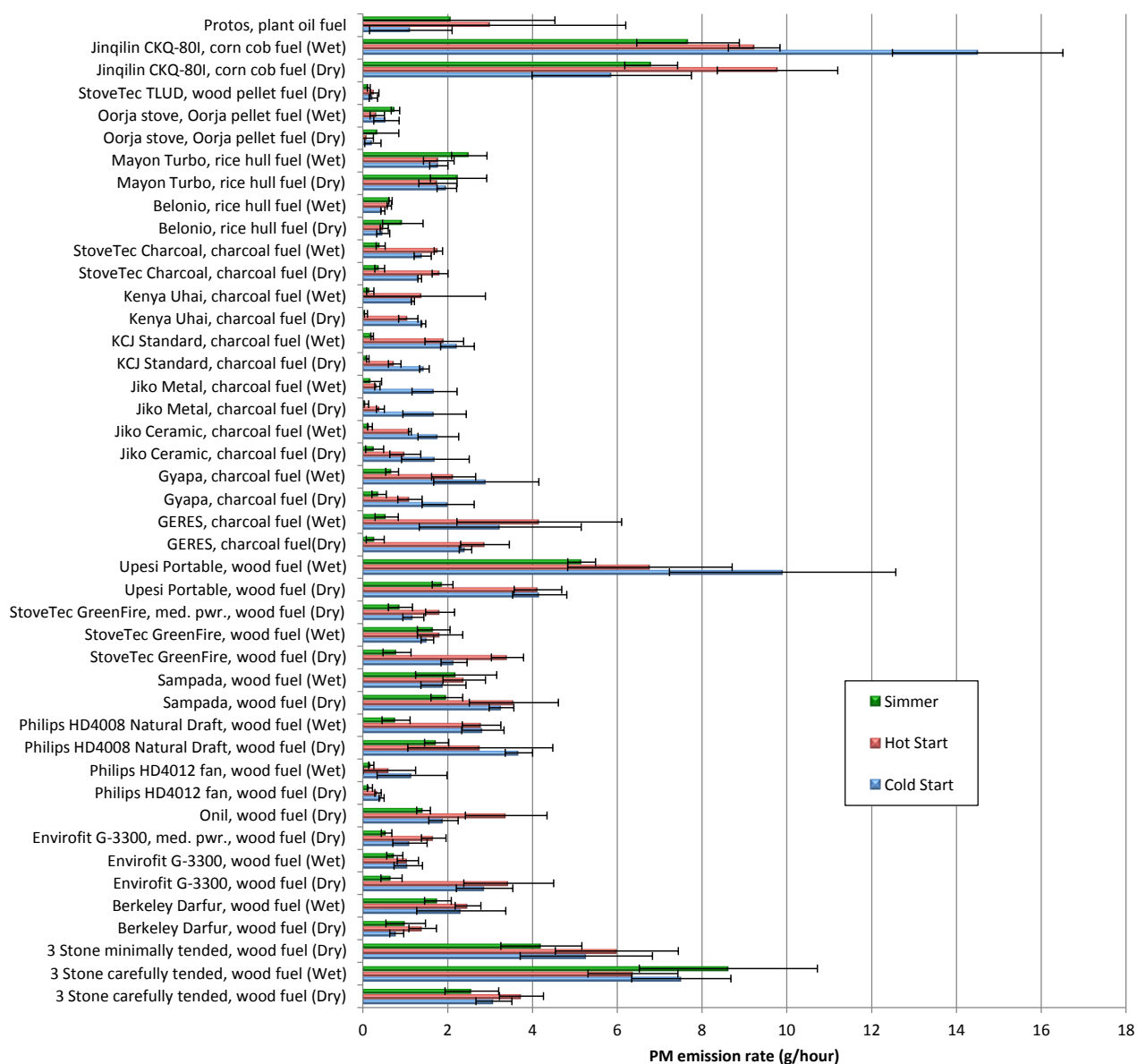
GERES, charcoal fuel (Wet)	82.7	20.7	52.2	27.1	29.1	11.1
Gyapa, charcoal fuel (Dry)	67.7	24.7	80.3	39.0	35.9	5.4
Gyapa, charcoal fuel (Wet)	79.5	6.9	101.2	12.5	42.2	3.9
KCJ Standard, charcoal fuel (Dry)	59.2	18.5	61.3	27.6	12.2	2.1
KCJ Standard, charcoal fuel (Wet)	89.5	8.3	86.6	16.8	17.9	4.3
Kenya Uhai, charcoal fuel (Dry)	54.9	16.9	43.4	6.4	14.2	1.8
Kenya Uhai, charcoal fuel (Wet)	33.9	4.9	39.8	23.6	13.9	2.3
StoveTec Charcoal, charcoal fuel (Dry)	25.4	3.9	33.5	6.8	13.6	4.2
StoveTec Charcoal, charcoal fuel (Wet)	29.5	3.5	37.3	4.1	12.5	1.4
Mayon Turbo, rice hull fuel (Dry)	29.2	1.6	28.3	3.0	20.5	2.3
Mayon Turbo, rice hull fuel (Wet)	26.4	1.2	29.7	2.0	21.1	0.7
Jinqilin CKQ-80I, corn cob fuel (Dry)	92.4	17.9	49.5	14.1	52.2	16.5
Jinqilin CKQ-80I, corn cob fuel (Wet)	206.6	5.6	61.9	20.3	91.2	43.2

Figure S28. CO Emission per WBT Task - 2 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Jiko Ceramic, charcoal fuel (Dry)	42.2	4.1	22.3	4.0	18.7	4.2
Jiko Ceramic, charcoal fuel (Wet)	35.7	6.4	26.2	8.0	17.0	3.7
Jiko Metal, charcoal fuel (Dry)	37.3	10.0	25.2	2.1	16.5	2.9
Jiko Metal, charcoal fuel (Wet)	27.3	4.6	18.9	2.2	12.5	1.8
Belonio, rice hull fuel (Dry)	12.3	0.4	9.7	2.2	11.3	7.1
Belonio, rice hull fuel (Wet)	13.5	1.0	16.2	3.3	23.5	3.0
Oorja stove, Oorja pellet fuel (Dry)	1.6	0.2	1.6	0.8	10.5	4.7
Oorja stove, Oorja pellet fuel (Wet)	2.6	0.1	0.9	0.2	3.7	
StoveTec TLUD, wood pellet fuel (Dry)	0.9	0.3	0.8	0.5	2.1	0.9
Protos, plant oil fuel	2.1	0.1	1.4	0.3	2.2	1.0

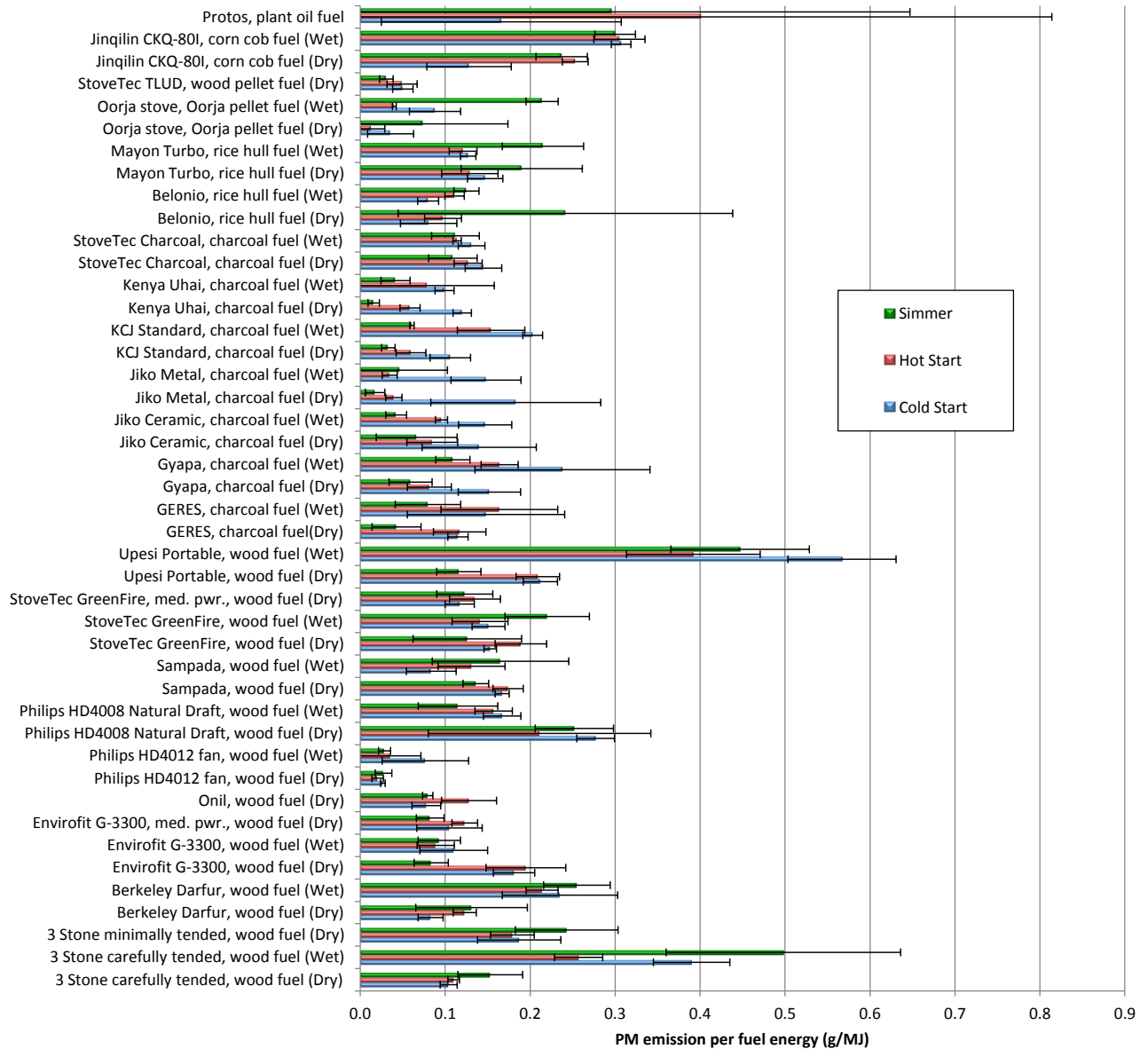
Figure S29. PM_{2.5} Emission Rate (per Time)



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	3.09	0.42	3.74	0.52	2.57	0.63
3 Stone carefully tended, wood fuel (Wet)	7.51	1.17	6.37	1.06	8.62	2.10
3 Stone minimally tended, wood fuel (Dry)	5.27	1.56	5.99	1.45	4.21	0.96
Berkeley Darfur, wood fuel (Dry)	0.80	0.17	1.41	0.33	1.01	0.47
Berkeley Darfur, wood fuel (Wet)	2.32	1.05	2.48	0.30	1.77	0.32
Envirofit G-3300, wood fuel (Dry)	2.87	0.67	3.44	1.06	0.68	0.25
Envirofit G-3300, wood fuel (Wet)	1.07	0.34	1.06	0.25	0.75	0.19
Envirofit G-3300, med. pwr., wood fuel (Dry)	1.11	0.41	1.67	0.29	0.56	0.12
Onil, wood fuel (Dry)	1.90	0.35	3.38	0.96	1.43	0.16
Philips HD4012 fan, wood fuel (Dry)	0.44	0.06	0.36	0.08	0.17	0.06
Philips HD4012 fan, wood fuel (Wet)	1.16	0.83	0.63	0.62	0.20	0.06
Philips HD4008 Natural Draft, wood fuel (Dry)	3.68	0.32	2.77	1.71	1.74	0.29
Philips HD4008 Natural Draft, wood fuel (Wet)	2.83	0.50	2.80	0.46	0.78	0.33
Sampada, wood fuel (Dry)	3.27	0.29	3.56	1.05	1.98	0.38
Sampada, wood fuel (Wet)	1.90	0.53	2.39	0.50	2.20	0.96

StoveTec GreenFire, wood fuel (Dry)	2.15	0.31	3.41	0.38	0.81	0.33
StoveTec GreenFire, wood fuel (Wet)	1.52	0.15	1.82	0.54	1.67	0.39
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1.19	0.25	1.82	0.34	0.88	0.28
Upesi Portable, wood fuel (Dry)	4.17	0.64	4.13	0.56	1.88	0.25
Upesi Portable, wood fuel (Wet)	9.90	2.67	6.77	1.94	5.16	0.33
GERES, charcoal fuel(Dry)	2.42	0.15	2.88	0.57	0.29	0.21
GERES, charcoal fuel (Wet)	3.24	1.91	4.16	1.94	0.56	0.27
Gyapa, charcoal fuel (Dry)	2.01	0.61	1.11	0.29	0.38	0.17
Gyapa, charcoal fuel (Wet)	2.91	1.24	2.14	0.52	0.69	0.15
Jiko Ceramic, charcoal fuel (Dry)	1.71	0.80	1.00	0.37	0.28	0.21
Jiko Ceramic, charcoal fuel (Wet)	1.78	0.48	1.11	0.03	0.17	0.06
Jiko Metal, charcoal fuel (Dry)	1.69	0.75	0.41	0.09	0.08	0.05
Jiko Metal, charcoal fuel (Wet)	1.69	0.53	0.34	0.06	0.20	0.24
KCJ Standard, charcoal fuel (Dry)	1.45	0.11	0.75	0.15	0.12	0.03
KCJ Standard, charcoal fuel (Wet)	2.23	0.40	1.92	0.46	0.22	0.03
Kenya Uhai, charcoal fuel (Dry)	1.43	0.05	1.07	0.23	0.07	0.04
Kenya Uhai, charcoal fuel (Wet)	1.18	0.04	1.40	1.49	0.17	0.09
StoveTec Charcoal, charcoal fuel (Dry)	1.34	0.04	1.82	0.19	0.40	0.12
StoveTec Charcoal, charcoal fuel (Wet)	1.41	0.20	1.78	0.10	0.42	0.11
Belonio, rice hull fuel (Dry)	0.48	0.15	0.50	0.10	0.94	0.48
Belonio, rice hull fuel (Wet)	0.47	0.05	0.62	0.05	0.65	0.04
Mayon Turbo, rice hull fuel (Dry)	1.98	0.23	1.77	0.45	2.26	0.66
Mayon Turbo, rice hull fuel (Wet)	1.79	0.22	1.79	0.36	2.51	0.42
Oorja stove, Oorja pellet fuel (Dry)	0.24	0.19	0.11	0.14	0.36	0.48
Oorja stove, Oorja pellet fuel (Wet)	0.56	0.30	0.34	0.17	0.77	0.10
StoveTec TLUD, wood pellet fuel (Dry)	0.25	0.10	0.28	0.10	0.14	0.03
Jinqilin CKQ-80l, corn cob fuel (Dry)	5.87	1.88	9.78	1.42	6.80	0.62
Jinqilin CKQ-80l, corn cob fuel (Wet)	14.50	2.01	9.23	0.61	7.67	1.21
Protos, plant oil fuel	1.13	0.97	3.01	3.19	2.09	2.44

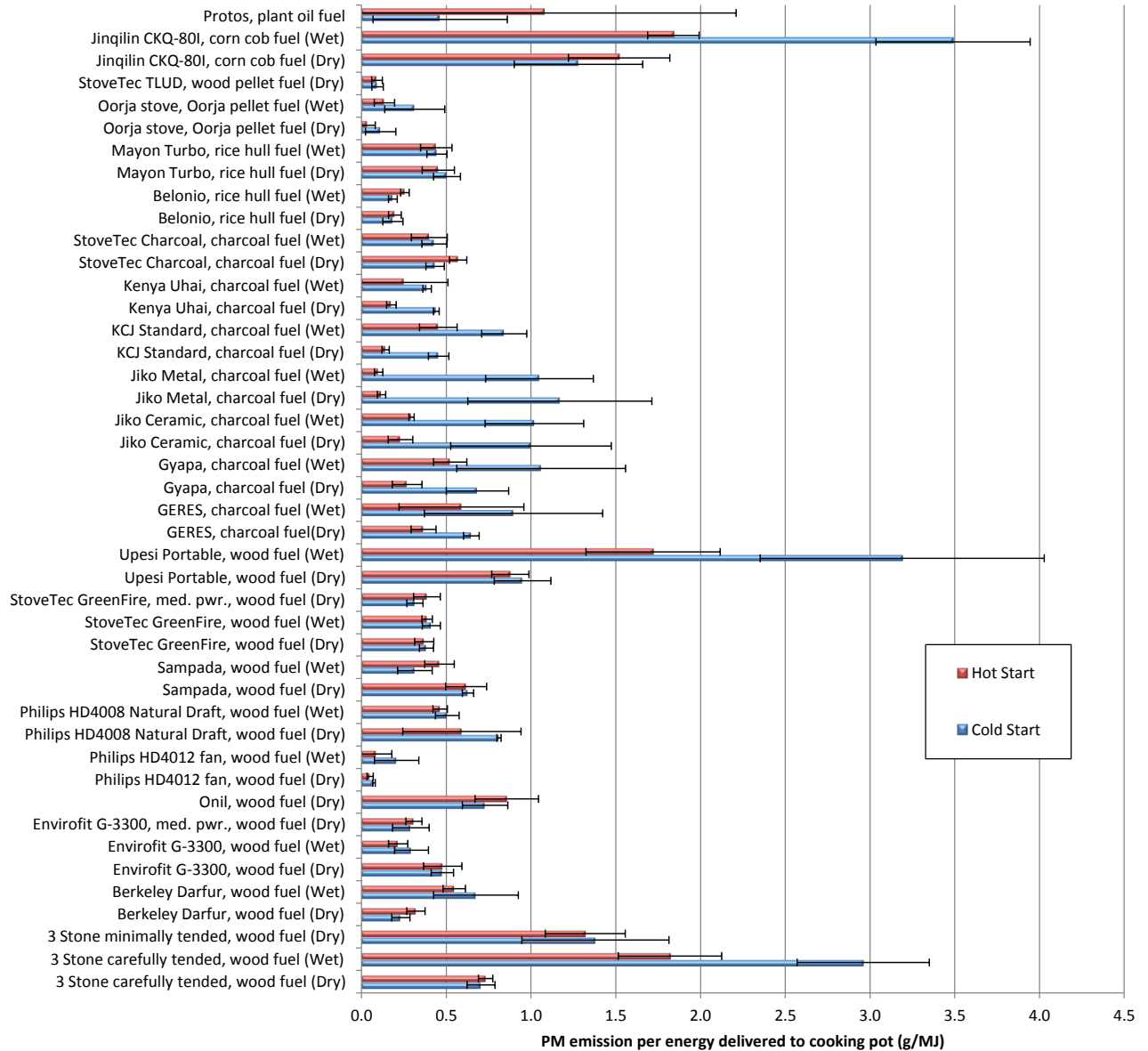
Figure S30. PM_{2.5} Emission per Fuel Energy



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	0.104	0.010	0.110	0.007	0.153	0.038
3 Stone carefully tended, wood fuel (Wet)	0.390	0.045	0.257	0.028	0.498	0.138
3 Stone minimally tended, wood fuel (Dry)	0.187	0.049	0.179	0.026	0.243	0.060
Berkeley Darfur, wood fuel (Dry)	0.083	0.015	0.123	0.014	0.131	0.066
Berkeley Darfur, wood fuel (Wet)	0.235	0.068	0.214	0.019	0.255	0.039
Envirofit G-3300, wood fuel (Dry)	0.181	0.024	0.195	0.047	0.084	0.020
Envirofit G-3300, wood fuel (Wet)	0.110	0.040	0.089	0.022	0.093	0.025
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.105	0.039	0.123	0.015	0.082	0.016
Onil, wood fuel (Dry)	0.078	0.017	0.128	0.032	0.079	0.006
Philips HD4012 fan, wood fuel (Dry)	0.027	0.003	0.020	0.007	0.027	0.010
Philips HD4012 fan, wood fuel (Wet)	0.077	0.051	0.036	0.036	0.029	0.007
Philips HD4008 Natural Draft, wood fuel (Dry)	0.277	0.022	0.211	0.131	0.252	0.046
Philips HD4008 Natural Draft, wood fuel (Wet)	0.167	0.022	0.157	0.022	0.115	0.047
Sampada, wood fuel (Dry)	0.167	0.008	0.174	0.018	0.136	0.015
Sampada, wood fuel (Wet)	0.084	0.029	0.131	0.039	0.165	0.080

StoveTec GreenFire, wood fuel (Dry)	0.153	0.007	0.189	0.030	0.126	0.064
StoveTec GreenFire, wood fuel (Wet)	0.151	0.019	0.141	0.033	0.220	0.050
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.117	0.017	0.135	0.030	0.123	0.033
Upesi Portable, wood fuel (Dry)	0.212	0.020	0.209	0.026	0.116	0.026
Upesi Portable, wood fuel (Wet)	0.567	0.064	0.392	0.079	0.447	0.082
GERES, charcoal fuel (Dry)	0.115	0.012	0.117	0.031	0.043	0.029
GERES, charcoal fuel (Wet)	0.148	0.093	0.164	0.069	0.080	0.039
Gyapa, charcoal fuel (Dry)	0.152	0.037	0.081	0.026	0.059	0.025
Gyapa, charcoal fuel (Wet)	0.238	0.103	0.164	0.022	0.109	0.020
Jiko Ceramic, charcoal fuel (Dry)	0.140	0.067	0.085	0.030	0.066	0.048
Jiko Ceramic, charcoal fuel (Wet)	0.147	0.031	0.096	0.007	0.042	0.012
Jiko Metal, charcoal fuel (Dry)	0.183	0.100	0.040	0.010	0.018	0.011
Jiko Metal, charcoal fuel (Wet)	0.148	0.041	0.035	0.009	0.047	0.056
KCJ Standard, charcoal fuel (Dry)	0.106	0.024	0.060	0.018	0.033	0.008
KCJ Standard, charcoal fuel (Wet)	0.203	0.012	0.154	0.040	0.061	0.003
Kenya Uhai, charcoal fuel (Dry)	0.120	0.011	0.059	0.012	0.016	0.007
Kenya Uhai, charcoal fuel (Wet)	0.099	0.011	0.079	0.079	0.042	0.017
StoveTec Charcoal, charcoal fuel (Dry)	0.145	0.022	0.127	0.017	0.109	0.029
StoveTec Charcoal, charcoal fuel (Wet)	0.131	0.016	0.114	0.005	0.112	0.028
Belonio, rice hull fuel (Dry)	0.081	0.033	0.097	0.022	0.242	0.197
Belonio, rice hull fuel (Wet)	0.080	0.012	0.111	0.011	0.125	0.015
Mayon Turbo, rice hull fuel (Dry)	0.147	0.021	0.129	0.033	0.190	0.071
Mayon Turbo, rice hull fuel (Wet)	0.127	0.009	0.121	0.016	0.215	0.048
Oorja stove, Oorja pellet fuel (Dry)	0.036	0.027	0.013	0.016	0.074	0.100
Oorja stove, Oorja pellet fuel (Wet)	0.088	0.030	0.040	0.002	0.214	0.019
StoveTec TLUD, wood pellet fuel (Dry)	0.050	0.012	0.049	0.018	0.031	0.008
Jinqilin CKQ-80I, corn cob fuel (Dry)	0.128	0.050	0.253	0.015	0.237	0.030
Jinqilin CKQ-80I, corn cob fuel (Wet)	0.307	0.012	0.305	0.030	0.300	0.024
Protos, plant oil fuel	0.166	0.141	0.401	0.413	0.296	0.351

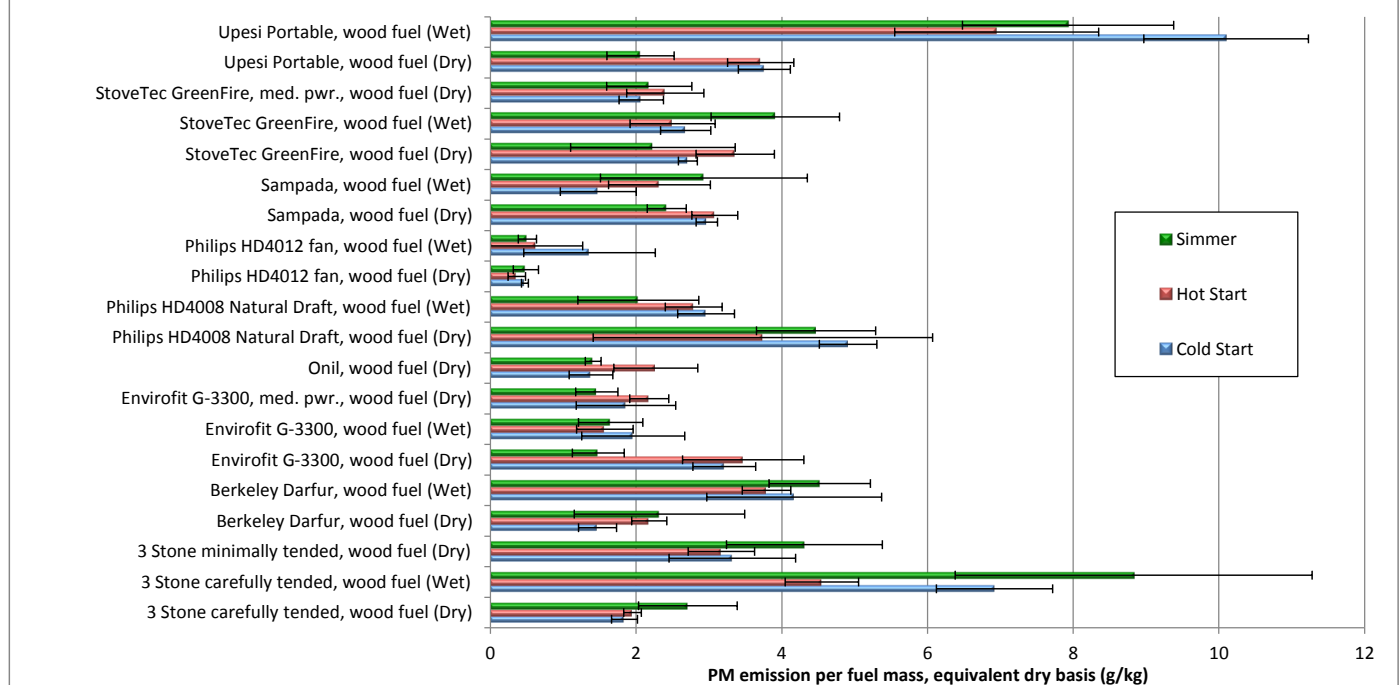
Figure S31. PM_{2.5} Emission per Energy Delivered to Cooking Pot



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	0.71	0.08	0.73	0.04
3 Stone carefully tended, wood fuel (Wet)	2.96	0.39	1.82	0.31
3 Stone minimally tended, wood fuel (Dry)	1.38	0.43	1.32	0.24
Berkeley Darfur, wood fuel (Dry)	0.23	0.05	0.32	0.05
Berkeley Darfur, wood fuel (Wet)	0.68	0.25	0.55	0.07
Envirofit G-3300, wood fuel (Dry)	0.48	0.07	0.48	0.11
Envirofit G-3300, wood fuel (Wet)	0.30	0.10	0.22	0.06
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.29	0.11	0.31	0.05
Onil, wood fuel (Dry)	0.73	0.13	0.86	0.19
Philips HD4012 fan, wood fuel (Dry)	0.07	0.01	0.05	0.02
Philips HD4012 fan, wood fuel (Wet)	0.21	0.13	0.09	0.09
Philips HD4008 Natural Draft, wood fuel (Dry)	0.81	0.01	0.59	0.35
Philips HD4008 Natural Draft, wood fuel (Wet)	0.51	0.07	0.46	0.04
Sampada, wood fuel (Dry)	0.63	0.03	0.62	0.12
Sampada, wood fuel (Wet)	0.32	0.10	0.46	0.09

StoveTec GreenFire, wood fuel (Dry)	0.38	0.04	0.37	0.06
StoveTec GreenFire, wood fuel (Wet)	0.41	0.05	0.39	0.03
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.32	0.05	0.39	0.08
Upesi Portable, wood fuel (Dry)	0.95	0.17	0.88	0.11
Upesi Portable, wood fuel (Wet)	3.19	0.84	1.72	0.40
GERES, charcoal fuel(Dry)	0.65	0.05	0.37	0.07
GERES, charcoal fuel (Wet)	0.90	0.53	0.59	0.37
Gyapa, charcoal fuel (Dry)	0.68	0.18	0.27	0.09
Gyapa, charcoal fuel (Wet)	1.06	0.50	0.52	0.10
Jiko Ceramic, charcoal fuel (Dry)	1.00	0.47	0.23	0.07
Jiko Ceramic, charcoal fuel (Wet)	1.02	0.29	0.30	0.02
Jiko Metal, charcoal fuel (Dry)	1.17	0.54	0.12	0.02
Jiko Metal, charcoal fuel (Wet)	1.05	0.32	0.10	0.02
KCJ Standard, charcoal fuel (Dry)	0.46	0.06	0.14	0.02
KCJ Standard, charcoal fuel (Wet)	0.84	0.13	0.45	0.11
Kenya Uhai, charcoal fuel (Dry)	0.44	0.02	0.18	0.03
Kenya Uhai, charcoal fuel (Wet)	0.39	0.03	0.25	0.26
StoveTec Charcoal, charcoal fuel (Dry)	0.43	0.05	0.57	0.05
StoveTec Charcoal, charcoal fuel (Wet)	0.43	0.07	0.40	0.11
Belonio, rice hull fuel (Dry)	0.19	0.06	0.20	0.04
Belonio, rice hull fuel (Wet)	0.19	0.03	0.26	0.03
Mayon Turbo, rice hull fuel (Dry)	0.50	0.08	0.45	0.10
Mayon Turbo, rice hull fuel (Wet)	0.45	0.06	0.44	0.09
Oorja stove, Oorja pellet fuel (Dry)	0.11	0.09	0.04	0.04
Oorja stove, Oorja pellet fuel (Wet)	0.31	0.18	0.14	0.06
StoveTec TLUD, wood pellet fuel (Dry)	0.09	0.03	0.09	0.03
Jinqilin CKQ-80l, corn cob fuel (Dry)	1.28	0.38	1.52	0.30
Jinqilin CKQ-80l, corn cob fuel (Wet)	3.49	0.46	1.84	0.15
Protos, plant oil fuel	0.46	0.40	1.08	1.13

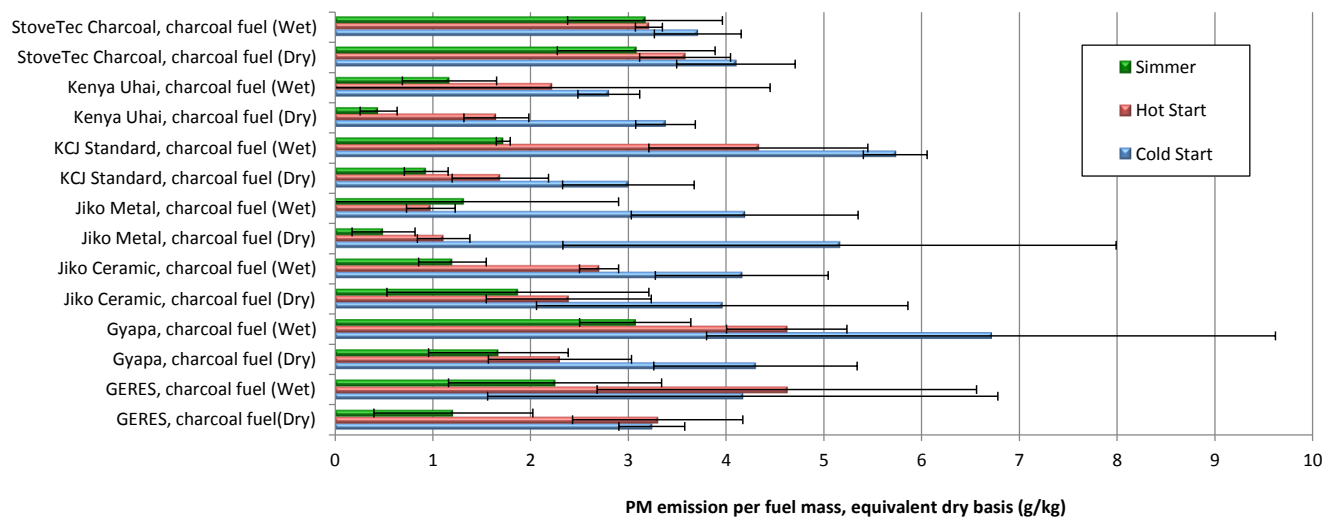
**Figure S32. PM_{2.5} Emission per Fuel Mass (Equivalent Dry Basis)
Wood Fuel**



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1.84	0.18	1.95	0.12	2.71	0.68
3 Stone carefully tended, wood fuel (Wet)	6.92	0.80	4.55	0.50	8.83	2.45
3 Stone minimally tended, wood fuel (Dry)	3.32	0.87	3.17	0.46	4.31	1.07

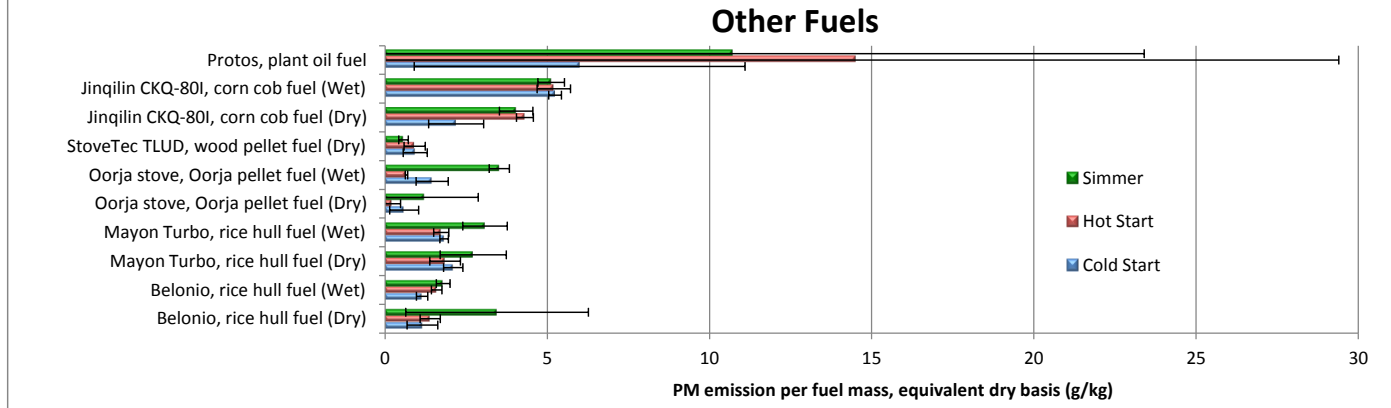
Berkeley Darfur, wood fuel (Dry)	1.47	0.26	2.18	0.24	2.32	1.17
Berkeley Darfur, wood fuel (Wet)	4.17	1.20	3.79	0.33	4.52	0.70
Envirofit G-3300, wood fuel (Dry)	3.21	0.43	3.47	0.83	1.48	0.36
Envirofit G-3300, wood fuel (Wet)	1.96	0.71	1.57	0.39	1.65	0.44
Envirofit G-3300, med. pwr., wood fuel (Dry)	1.86	0.68	2.18	0.27	1.46	0.29
Onil, wood fuel (Dry)	1.38	0.30	2.27	0.58	1.41	0.11
Philips HD4008 Natural Draft, wood fuel (Dry)	4.91	0.40	3.74	2.33	4.47	0.82
Philips HD4008 Natural Draft, wood fuel (Wet)	2.96	0.39	2.79	0.39	2.03	0.83
Philips HD4012 fan, wood fuel (Dry)	0.47	0.05	0.36	0.12	0.49	0.17
Philips HD4012 fan, wood fuel (Wet)	1.36	0.90	0.63	0.64	0.51	0.13
Sampada, wood fuel (Dry)	2.97	0.15	3.08	0.32	2.42	0.27
Sampada, wood fuel (Wet)	1.48	0.52	2.32	0.70	2.93	1.42
StoveTec GreenFire, wood fuel (Dry)	2.71	0.13	3.36	0.54	2.23	1.13
StoveTec GreenFire, wood fuel (Wet)	2.68	0.35	2.50	0.58	3.91	0.88
StoveTec GreenFire, med. pwr., wood fuel (Dry)	2.07	0.31	2.40	0.53	2.18	0.59
Upesi Portable, wood fuel (Dry)	3.76	0.36	3.71	0.46	2.06	0.46
Upesi Portable, wood fuel (Wet)	10.10	1.13	6.95	1.40	7.93	1.45

Figure S33. PM_{2.5} Emission per Fuel Mass (Equivalent Dry Basis) - Charcoal Fuel



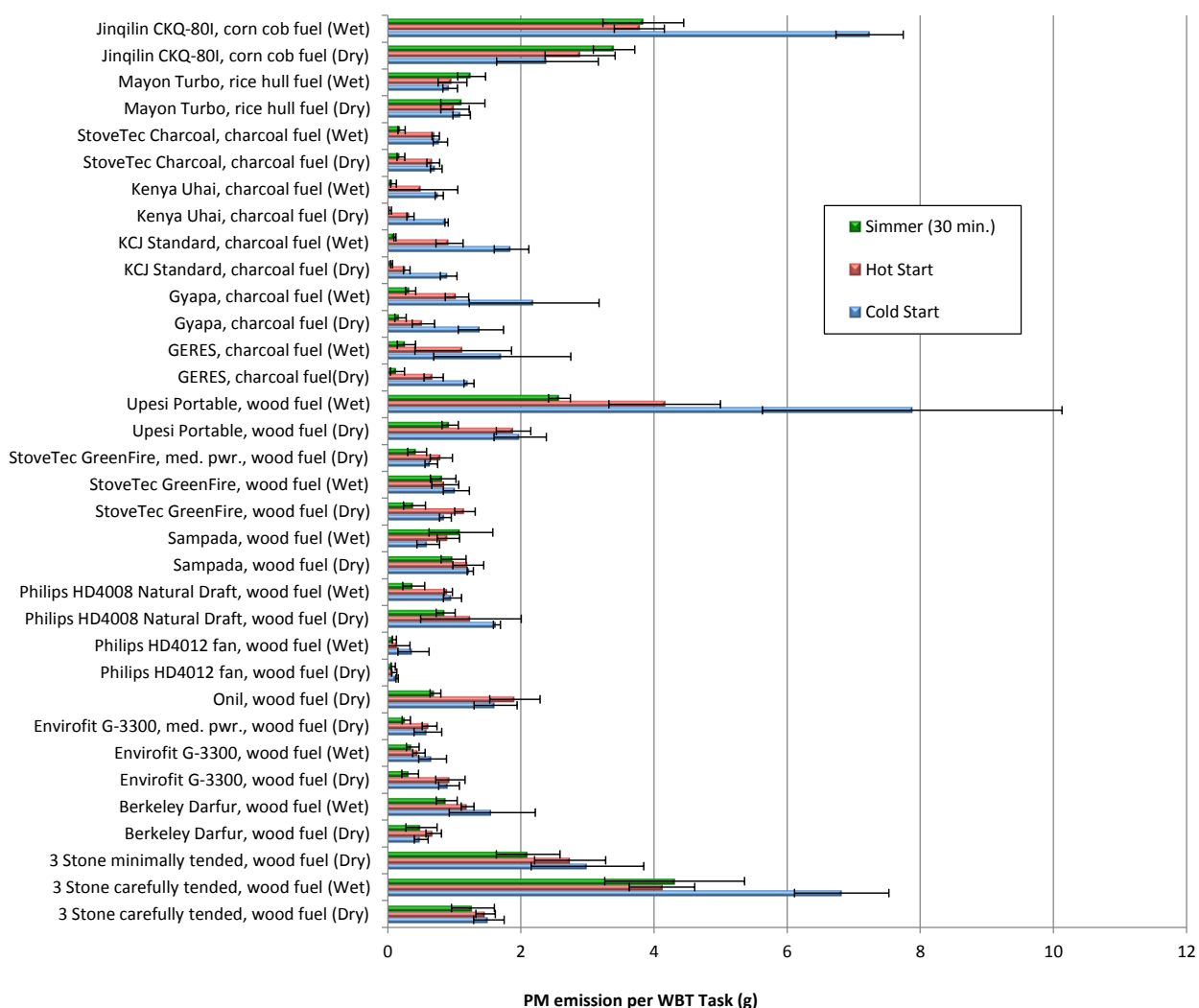
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel(Dry)	3.24	0.34	3.30	0.87	1.21	0.81
GERES, charcoal fuel (Wet)	4.17	2.61	4.62	1.94	2.25	1.09
Gyapa, charcoal fuel (Dry)	4.30	1.04	2.30	0.73	1.67	0.71
Gyapa, charcoal fuel (Wet)	6.71	2.91	4.62	0.62	3.07	0.57
Jiko Ceramic, charcoal fuel (Dry)	3.96	1.90	2.39	0.84	1.87	1.34
Jiko Ceramic, charcoal fuel (Wet)	4.16	0.88	2.70	0.20	1.20	0.35
Jiko Metal, charcoal fuel (Dry)	5.16	2.83	1.11	0.27	0.50	0.32
Jiko Metal, charcoal fuel (Wet)	4.19	1.16	0.98	0.25	1.32	1.58
KCJ Standard, charcoal fuel (Dry)	3.00	0.67	1.69	0.49	0.93	0.22
KCJ Standard, charcoal fuel (Wet)	5.73	0.33	4.33	1.12	1.72	0.07
Kenya Uhai, charcoal fuel (Dry)	3.38	0.31	1.65	0.33	0.45	0.19
Kenya Uhai, charcoal fuel (Wet)	2.80	0.32	2.22	2.23	1.17	0.48
StoveTec Charcoal, charcoal fuel (Dry)	4.10	0.61	3.58	0.47	3.08	0.81
StoveTec Charcoal, charcoal fuel (Wet)	3.71	0.44	3.21	0.14	3.17	0.79

Figure S34. PM_{2.5} Emission per Fuel Mass (Equivalent Dry Basis)



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	1.15	0.47	1.39	0.31	3.45	2.82
Belonio, rice hull fuel (Wet)	1.14	0.18	1.59	0.16	1.79	0.21
Mayon Turbo, rice hull fuel (Dry)	2.10	0.30	1.85	0.47	2.72	1.02
Mayon Turbo, rice hull fuel (Wet)	1.82	0.13	1.73	0.23	3.08	0.69
Oorja stove, Oorja pellet fuel (Dry)	0.59	0.45	0.22	0.26	1.22	1.65
Oorja stove, Oorja pellet fuel (Wet)	1.45	0.50	0.66	0.04	3.52	0.31
StoveTec TLUD, wood pellet fuel (Dry)	0.93	0.37	0.91	0.33	0.57	0.15
Jinqilin CKQ-80I, corn cob fuel (Dry)	2.19	0.85	4.31	0.26	4.04	0.52
Jinqilin CKQ-80I, corn cob fuel (Wet)	5.24	0.20	5.20	0.52	5.12	0.41
Protos, plant oil fuel	6.00	5.10	14.50	14.90	10.70	12.70

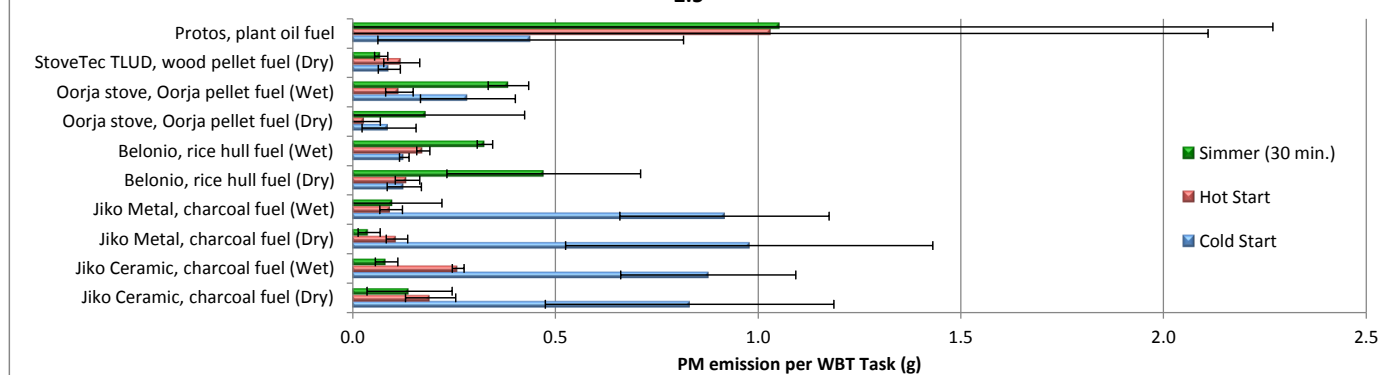
Figure S35. PM_{2.5} Emission per WBT Task - 5 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1.52	0.23	1.47	0.15	1.28	0.32
3 Stone carefully tended, wood fuel (Wet)	6.82	0.71	4.12	0.49	4.31	1.05
3 Stone minimally tended, wood fuel (Dry)	3.00	0.85	2.74	0.53	2.11	0.48
Berkeley Darfur, wood fuel (Dry)	0.50	0.10	0.69	0.12	0.51	0.23
Berkeley Darfur, wood fuel (Wet)	1.57	0.65	1.20	0.10	0.89	0.16
Envirofit G-3300, wood fuel (Dry)	0.92	0.16	0.94	0.22	0.34	0.13
Envirofit G-3300, wood fuel (Wet)	0.67	0.21	0.47	0.09	0.38	0.10
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.60	0.21	0.63	0.11	0.28	0.06
Onil, wood fuel (Dry)	1.62	0.32	1.91	0.38	0.72	0.08
Philips HD4012 fan, wood fuel (Dry)	0.14	0.02	0.10	0.04	0.08	0.03
Philips HD4012 fan, wood fuel (Wet)	0.39	0.23	0.17	0.17	0.10	0.03
Philips HD4008 Natural Draft, wood fuel (Dry)	1.64	0.05	1.25	0.76	0.87	0.14
Philips HD4008 Natural Draft, wood fuel (Wet)	0.97	0.14	0.91	0.06	0.39	0.17
Sampada, wood fuel (Dry)	1.24	0.05	1.21	0.23	0.99	0.19
Sampada, wood fuel (Wet)	0.61	0.17	0.91	0.17	1.10	0.48
StoveTec GreenFire, wood fuel (Dry)	0.87	0.09	1.16	0.15	0.40	0.17
StoveTec GreenFire, wood fuel (Wet)	1.03	0.20	0.86	0.20	0.83	0.19
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.65	0.09	0.81	0.17	0.44	0.14
Upesi Portable, wood fuel (Dry)	1.99	0.39	1.89	0.26	0.94	0.12
Upesi Portable, wood fuel (Wet)	7.88	2.25	4.16	0.84	2.58	0.16
GERES, charcoal fuel(Dry)	1.22	0.08	0.69	0.14	0.15	0.11

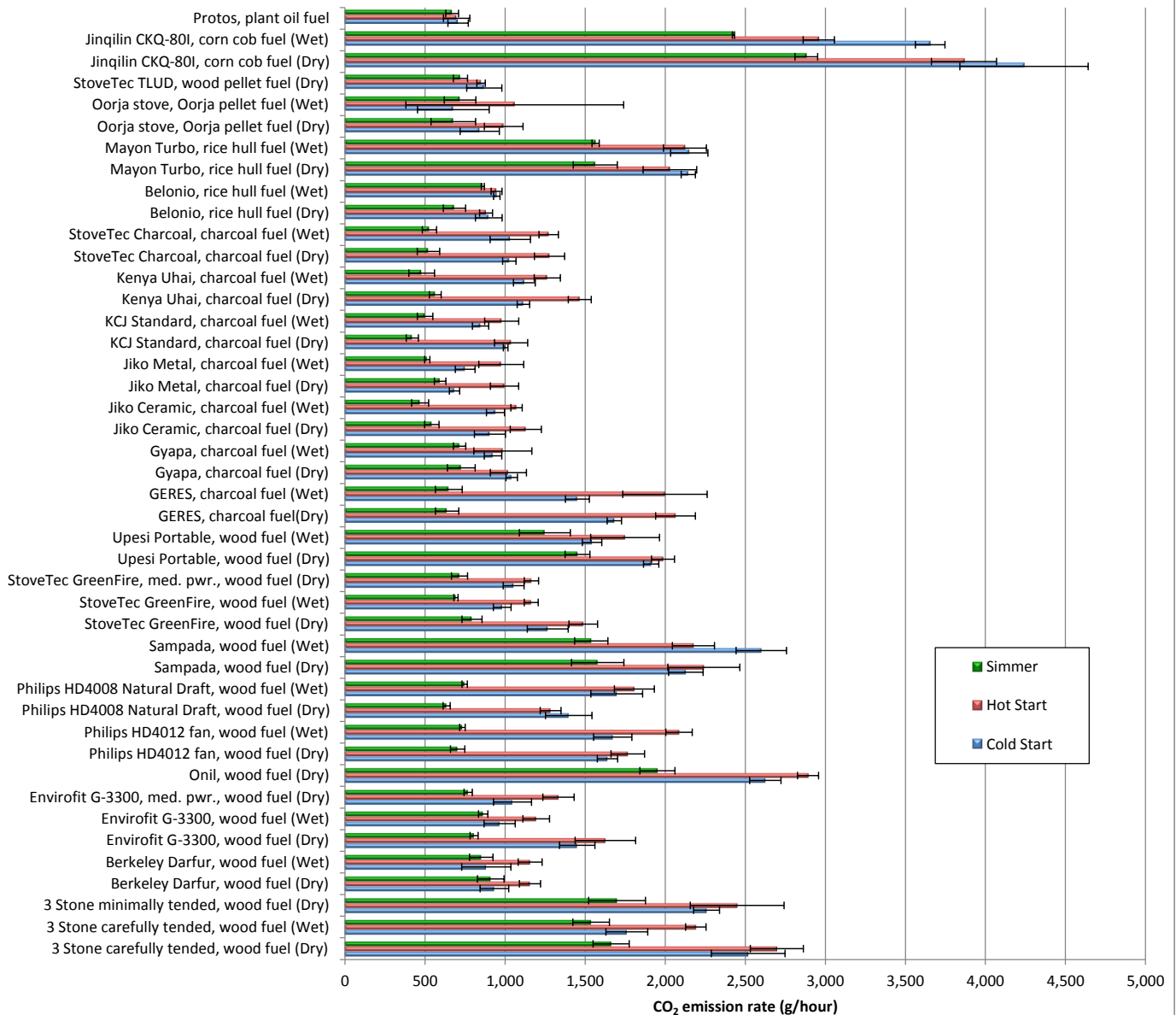
GERES, charcoal fuel (Wet)	1.72	1.03	1.13	0.73	0.28	0.14
Gyapa, charcoal fuel (Dry)	1.40	0.34	0.54	0.17	0.19	0.09
Gyapa, charcoal fuel (Wet)	2.20	0.98	1.04	0.18	0.35	0.08
KCJ Standard, charcoal fuel (Dry)	0.92	0.13	0.29	0.05	0.06	0.01
KCJ Standard, charcoal fuel (Wet)	1.86	0.26	0.93	0.20	0.11	0.01
Kenya Uhai, charcoal fuel (Dry)	0.88	0.02	0.34	0.05	0.04	0.02
Kenya Uhai, charcoal fuel (Wet)	0.77	0.06	0.52	0.54	0.09	0.04
StoveTec Charcoal, charcoal fuel (Dry)	0.73	0.09	0.68	0.10	0.20	0.06
StoveTec Charcoal, charcoal fuel (Wet)	0.79	0.11	0.72	0.06	0.21	0.05
Mayon Turbo, rice hull fuel (Dry)	1.11	0.13	1.01	0.21	1.13	0.33
Mayon Turbo, rice hull fuel (Wet)	0.94	0.11	0.97	0.22	1.26	0.21
Jinqilin CKQ-80I, corn cob fuel (Dry)	2.40	0.76	2.89	0.53	3.40	0.31
Jinqilin CKQ-80I, corn cob fuel (Wet)	7.24	0.51	3.78	0.38	3.84	0.61

Figure S36. PM_{2.5} Emission per WBT Task - 2 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Jiko Ceramic, charcoal fuel (Dry)	0.83	0.36	0.19	0.06	0.14	0.11
Jiko Ceramic, charcoal fuel (Wet)	0.88	0.22	0.26	0.01	0.08	0.03
Jiko Metal, charcoal fuel (Dry)	0.98	0.45	0.11	0.03	0.04	0.03
Jiko Metal, charcoal fuel (Wet)	0.92	0.26	0.09	0.03	0.10	0.12
Belonio, rice hull fuel (Dry)	0.13	0.04	0.14	0.03	0.47	0.24
Belonio, rice hull fuel (Wet)	0.13	0.01	0.17	0.02	0.33	0.02
Oorja stove, Oorja pellet fuel (Dry)	0.09	0.07	0.03	0.04	0.18	0.24
Oorja stove, Oorja pellet fuel (Wet)	0.28	0.12	0.12	0.03	0.38	0.05
StoveTec TLUD, wood pellet fuel (Dry)	0.09	0.03	0.12	0.04	0.07	0.02
Protos, plant oil fuel	0.44	0.38	1.03	1.08	1.05	1.22

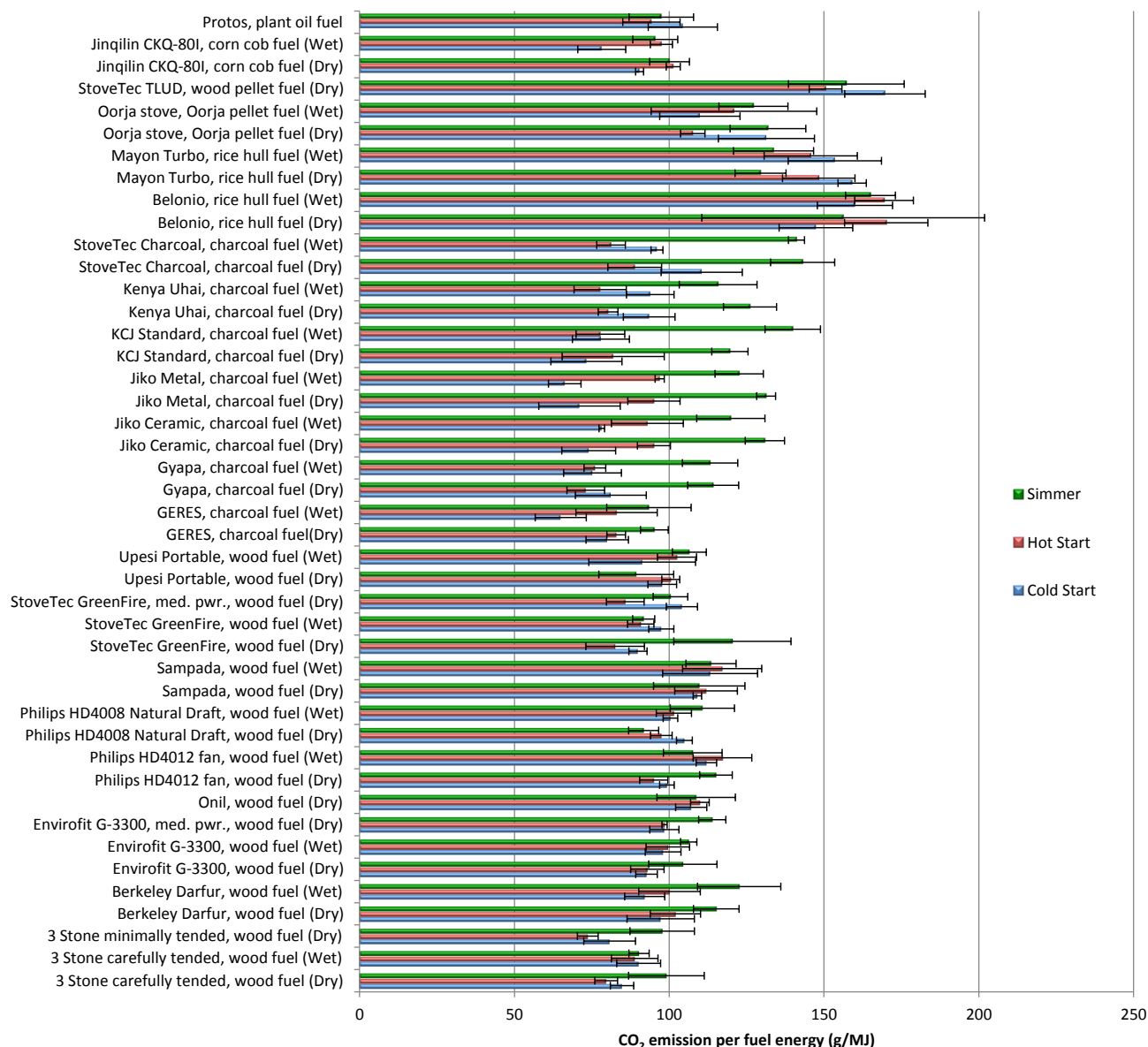
Figure S37. CO₂ Emission Rate (per Time)



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	2,518	230	2,697	166	1,662	113
3 Stone carefully tended, wood fuel (Wet)	1,760	131	2,191	64	1,537	114
3 Stone minimally tended, wood fuel (Dry)	2,258	81	2,449	293	1,699	178
Berkeley Darfur, wood fuel (Dry)	933	89	1,155	66	910	83
Berkeley Darfur, wood fuel (Wet)	882	154	1,156	75	851	73
Envirofit G-3300, wood fuel (Dry)	1,450	111	1,626	189	806	25
Envirofit G-3300, wood fuel (Wet)	966	97	1,194	83	863	29
Envirofit G-3300, med. pwr., wood fuel (Dry)	1,046	119	1,333	98	769	26
Onil, wood fuel (Dry)	2,625	98	2,892	66	1,951	110
Philips HD4012 fan, wood fuel (Dry)	1,639	64	1,766	105	703	45
Philips HD4012 fan, wood fuel (Wet)	1,672	120	2,086	83	733	17
Philips HD4008 Natural Draft, wood fuel (Dry)	1,397	145	1,284	65	635	22
Philips HD4008 Natural Draft, wood fuel (Wet)	1,697	162	1,807	125	747	16
Sampada, wood fuel (Dry)	2,129	108	2,241	225	1,578	164

Sampada, wood fuel (Wet)	2,600	158	2,176	132	1,538	104
StoveTec GreenFire, wood fuel (Dry)	1,266	128	1,488	89	793	63
StoveTec GreenFire, wood fuel (Wet)	982	55	1,163	43	693	13
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1,053	65	1,164	45	715	50
Upesi Portable, wood fuel (Dry)	1,912	48	1,986	72	1,452	78
Upesi Portable, wood fuel (Wet)	1,543	61	1,749	215	1,248	159
GERES, charcoal fuel(Dry)	1,682	45	2,064	124	637	73
GERES, charcoal fuel (Wet)	1,451	75	1,998	264	648	84
Gyapa, charcoal fuel (Dry)	1,041	36	1,020	113	726	87
Gyapa, charcoal fuel (Wet)	924	55	986	181	715	38
Jiko Ceramic, charcoal fuel (Dry)	905	97	1,129	97	542	45
Jiko Ceramic, charcoal fuel (Wet)	940	56	1,071	35	469	53
Jiko Metal, charcoal fuel (Dry)	684	32	996	89	594	36
Jiko Metal, charcoal fuel (Wet)	750	62	976	140	513	16
KCJ Standard, charcoal fuel (Dry)	1,003	14	1,037	104	420	38
KCJ Standard, charcoal fuel (Wet)	846	51	978	106	500	49
Kenya Uhai, charcoal fuel (Dry)	1,114	39	1,466	72	564	37
Kenya Uhai, charcoal fuel (Wet)	1,120	68	1,263	82	479	80
StoveTec Charcoal, charcoal fuel (Dry)	1,026	42	1,277	94	521	70
StoveTec Charcoal, charcoal fuel (Wet)	1,032	126	1,272	61	527	44
Belonio, rice hull fuel (Dry)	898	84	881	40	683	70
Belonio, rice hull fuel (Wet)	948	20	946	34	860	9
Mayon Turbo, rice hull fuel (Dry)	2,144	44	2,029	168	1,563	138
Mayon Turbo, rice hull fuel (Wet)	2,150	117	2,123	134	1,565	23
Oorja stove, Oorja pellet fuel (Dry)	841	122	991	121	676	139
Oorja stove, Oorja pellet fuel (Wet)	677	224	1,060	680	718	99
StoveTec TLUD, wood pellet fuel (Dry)	870	110	850	26	721	44
Jinqilin CKQ-80I, corn cob fuel (Dry)	4,241	400	3,866	203	2,881	71
Jinqilin CKQ-80I, corn cob fuel (Wet)	3,655	92	2,959	98	2,426	7
Protos, plant oil fuel	706	64	697	82	669	40

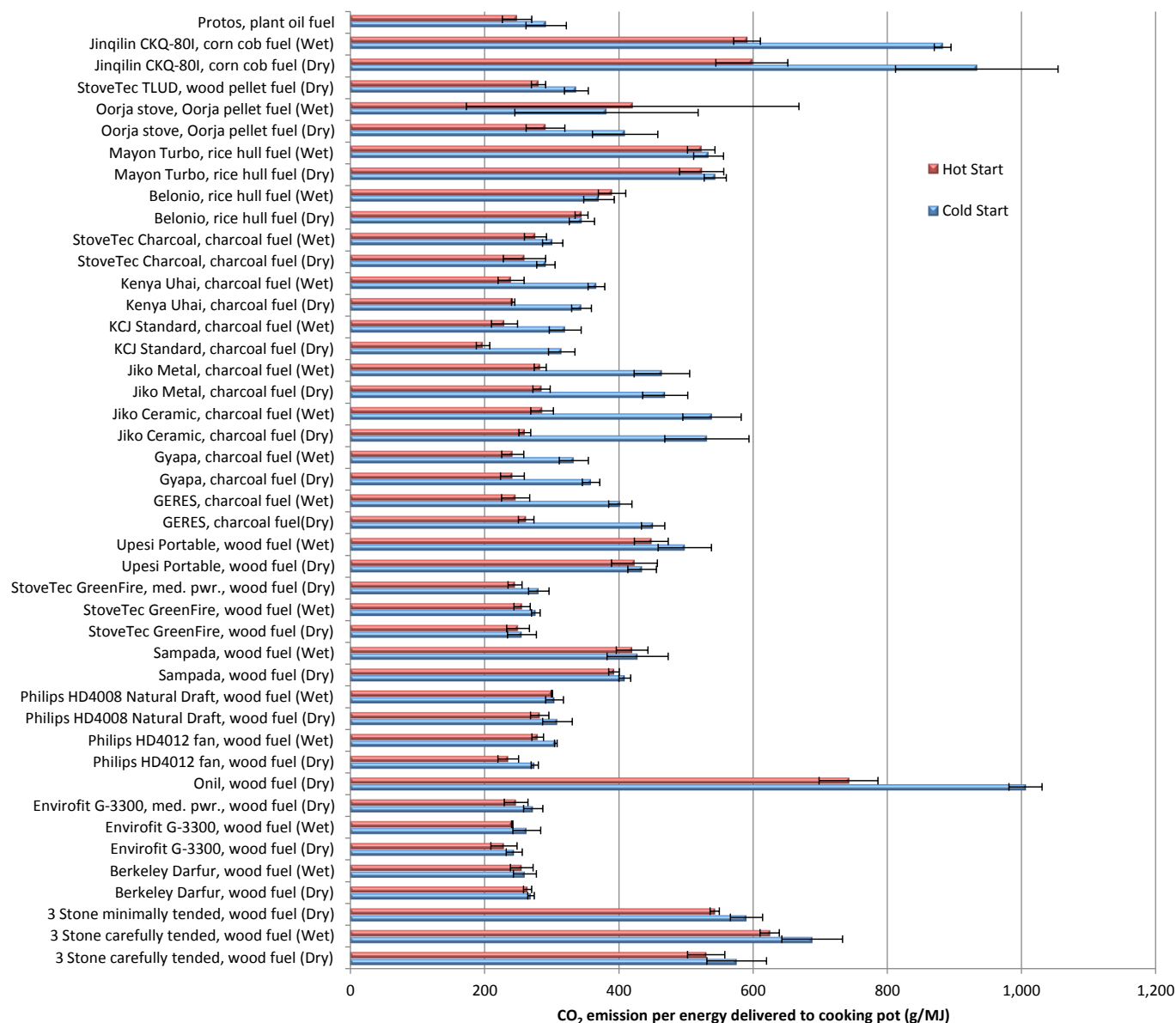
Figure S38. CO₂ Emission per Fuel Energy



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	84.8	3.8	79.6	3.7	99.1	12.2
3 Stone carefully tended, wood fuel (Wet)	90.1	7.1	88.8	7.5	90.3	3.3
3 Stone minimally tended, wood fuel (Dry)	80.7	8.3	73.7	3.4	97.7	10.4
Berkeley Darfur, wood fuel (Dry)	97.3	10.9	102.0	8.1	115.2	7.4
Berkeley Darfur, wood fuel (Wet)	92.1	6.5	100.1	9.9	122.6	13.5
Envirofit G-3300, wood fuel (Dry)	92.7	3.5	92.9	5.4	104.4	11.0
Envirofit G-3300, wood fuel (Wet)	98.0	5.8	99.5	7.0	106.3	2.6
Envirofit G-3300, med. pwr., wood fuel (Dry)	98.4	4.7	98.5	0.8	113.9	4.4
Onil, wood fuel (Dry)	107.1	5.0	109.9	3.0	108.7	12.7
Philips HD4012 fan, wood fuel (Dry)	99.3	2.4	95.0	4.5	115.1	5.3
Philips HD4012 fan, wood fuel (Wet)	112.0	3.3	117.2	9.5	107.6	9.5
Philips HD4008 Natural Draft, wood fuel (Dry)	104.9	2.6	97.4	3.5	91.7	4.9
Philips HD4008 Natural Draft, wood fuel (Wet)	100.4	2.4	101.5	5.7	110.7	10.4
Sampada, wood fuel (Dry)	109.1	1.4	111.9	10.1	109.7	14.8
Sampada, wood fuel (Wet)	113.2	15.3	117.1	12.8	113.5	8.1

StoveTec GreenFire, wood fuel (Dry)	89.9	2.9	82.5	9.5	120.4	18.9
StoveTec GreenFire, wood fuel (Wet)	97.4	4.1	90.8	4.3	91.8	3.6
StoveTec GreenFire, med. pwr., wood fuel (Dry)	104.1	5.0	85.8	6.1	100.4	5.6
Upesi Portable, wood fuel (Dry)	97.8	4.6	100.5	2.9	89.4	12.1
Upesi Portable, wood fuel (Wet)	91.3	17.2	102.5	6.3	106.5	5.5
GERES, charcoal fuel(Dry)	80.0	6.8	82.9	3.0	95.2	4.5
GERES, charcoal fuel (Wet)	65.0	8.2	83.0	13.1	93.4	13.6
Gyapa, charcoal fuel (Dry)	81.1	11.5	73.0	6.1	114.2	8.2
Gyapa, charcoal fuel (Wet)	75.2	9.3	76.0	3.5	113.2	8.9
Jiko Ceramic, charcoal fuel (Dry)	74.0	8.7	95.1	5.3	130.9	6.3
Jiko Ceramic, charcoal fuel (Wet)	78.2	0.9	92.9	11.6	119.9	11.0
Jiko Metal, charcoal fuel (Dry)	71.0	13.2	95.1	8.4	131.3	3.0
Jiko Metal, charcoal fuel (Wet)	66.3	5.3	96.9	1.5	122.6	7.8
KCJ Standard, charcoal fuel (Dry)	73.3	11.5	81.9	16.5	119.6	5.9
KCJ Standard, charcoal fuel (Wet)	77.9	9.2	77.8	7.9	139.9	9.0
Kenya Uhai, charcoal fuel (Dry)	93.5	8.4	80.3	3.2	126.1	8.6
Kenya Uhai, charcoal fuel (Wet)	93.9	7.7	77.7	8.4	115.8	12.6
StoveTec Charcoal, charcoal fuel (Dry)	110.5	13.1	88.9	8.7	143.1	10.4
StoveTec Charcoal, charcoal fuel (Wet)	96.0	1.9	81.2	4.6	141.1	2.6
Belonio, rice hull fuel (Dry)	147.4	11.9	170.1	13.5	156.2	45.7
Belonio, rice hull fuel (Wet)	160.0	12.2	169.4	9.5	165.0	8.0
Mayon Turbo, rice hull fuel (Dry)	159.1	4.6	148.3	11.7	129.5	8.2
Mayon Turbo, rice hull fuel (Wet)	153.5	15.1	145.7	15.1	133.7	12.9
Oorja stove, Oorja pellet fuel (Dry)	131.4	15.5	107.6	3.9	131.9	12.2
Oorja stove, Oorja pellet fuel (Wet)	109.9	13.0	120.9	26.7	127.2	11.2
StoveTec TLUD, wood pellet fuel (Dry)	169.7	13.0	150.5	5.3	157.2	18.7
Jinqilin CKQ-80l, corn cob fuel (Dry)	90.4	1.3	101.3	2.3	100.1	6.4
Jinqilin CKQ-80l, corn cob fuel (Wet)	78.2	7.7	97.5	3.6	95.5	7.3
Protos, plant oil fuel	104.4	11.2	94.3	9.2	97.5	10.4

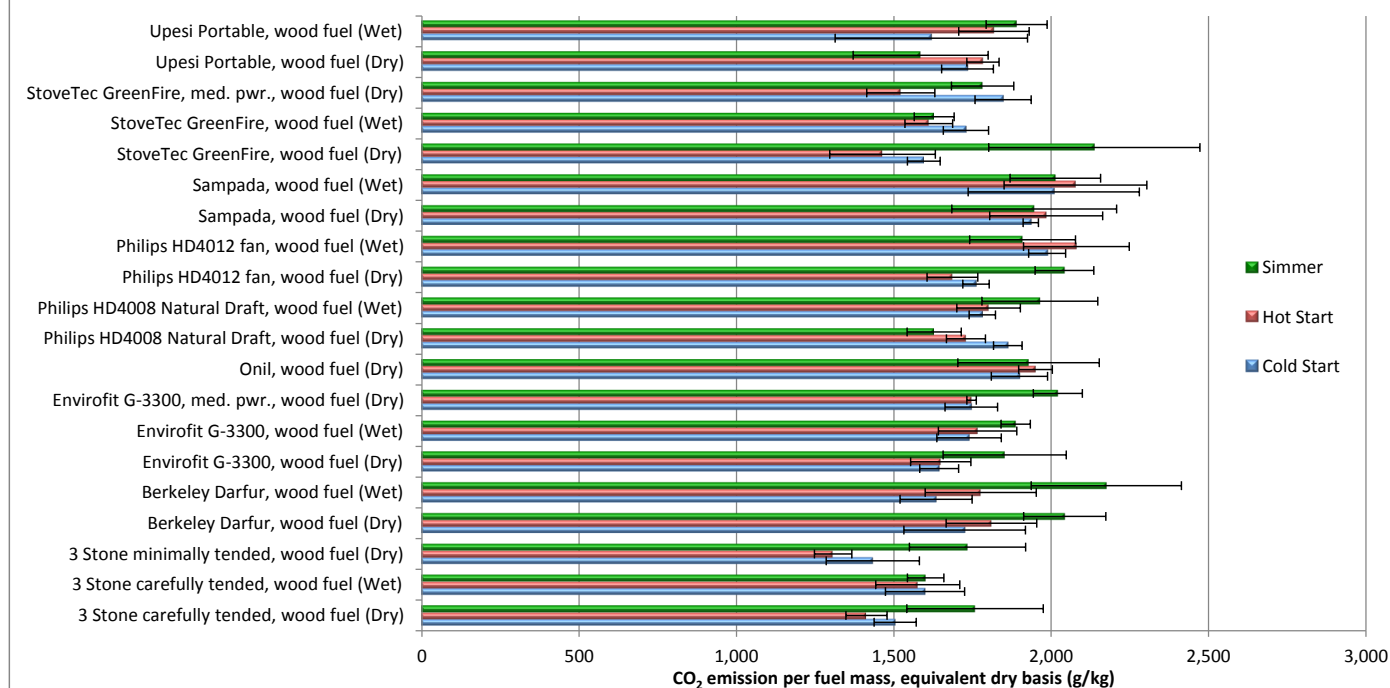
Figure S39. CO₂ Emission per Energy Delivered to Cooking Pot



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	576	44	530	28
3 Stone carefully tended, wood fuel (Wet)	688	45	625	14
3 Stone minimally tended, wood fuel (Dry)	590	24	543	7
Berkeley Darfur, wood fuel (Dry)	269	5	264	6
Berkeley Darfur, wood fuel (Wet)	260	17	255	17
Envirofit G-3300, wood fuel (Dry)	244	12	229	20
Envirofit G-3300, wood fuel (Wet)	263	21	241	1
Envirofit G-3300, med. pwr., wood fuel (Dry)	272	14	247	18
Onil, wood fuel (Dry)	1,006	25	742	44
Philips HD4012 fan, wood fuel (Dry)	275	5	235	15
Philips HD4012 fan, wood fuel (Wet)	306	2	279	9
Philips HD4008 Natural Draft, wood fuel (Dry)	308	22	282	14
Philips HD4008 Natural Draft, wood fuel (Wet)	304	13	300	1
Sampada, wood fuel (Dry)	409	9	393	8
Sampada, wood fuel (Wet)	428	46	420	24

StoveTec GreenFire, wood fuel (Dry)	256	22	250	17
StoveTec GreenFire, wood fuel (Wet)	276	6	256	12
StoveTec GreenFire, med. pwr., wood fuel (Dry)	281	15	245	10
Upesi Portable, wood fuel (Dry)	435	21	423	34
Upesi Portable, wood fuel (Wet)	498	40	448	25
GERES, charcoal fuel(Dry)	451	17	262	12
GERES, charcoal fuel (Wet)	402	17	246	21
Gyapa, charcoal fuel (Dry)	359	13	241	18
Gyapa, charcoal fuel (Wet)	333	22	242	16
Jiko Ceramic, charcoal fuel (Dry)	531	63	260	9
Jiko Ceramic, charcoal fuel (Wet)	539	44	286	17
Jiko Metal, charcoal fuel (Dry)	469	34	285	13
Jiko Metal, charcoal fuel (Wet)	464	41	283	9
KCJ Standard, charcoal fuel (Dry)	315	20	198	10
KCJ Standard, charcoal fuel (Wet)	320	24	230	19
Kenya Uhai, charcoal fuel (Dry)	344	15	242	2
Kenya Uhai, charcoal fuel (Wet)	367	12	239	19
StoveTec Charcoal, charcoal fuel (Dry)	291	14	259	32
StoveTec Charcoal, charcoal fuel (Wet)	301	15	276	16
Belonio, rice hull fuel (Dry)	345	19	344	10
Belonio, rice hull fuel (Wet)	370	23	390	20
Mayon Turbo, rice hull fuel (Dry)	544	16	523	33
Mayon Turbo, rice hull fuel (Wet)	534	22	523	20
Oorja stove, Oorja pellet fuel (Dry)	409	49	291	29
Oorja stove, Oorja pellet fuel (Wet)	382	137	421	248
StoveTec TLUD, wood pellet fuel (Dry)	337	18	280	11
Jinqilin CKQ-80l, corn cob fuel (Dry)	933	121	598	54
Jinqilin CKQ-80l, corn cob fuel (Wet)	883	12	591	20
Protos, plant oil fuel	292	30	248	22

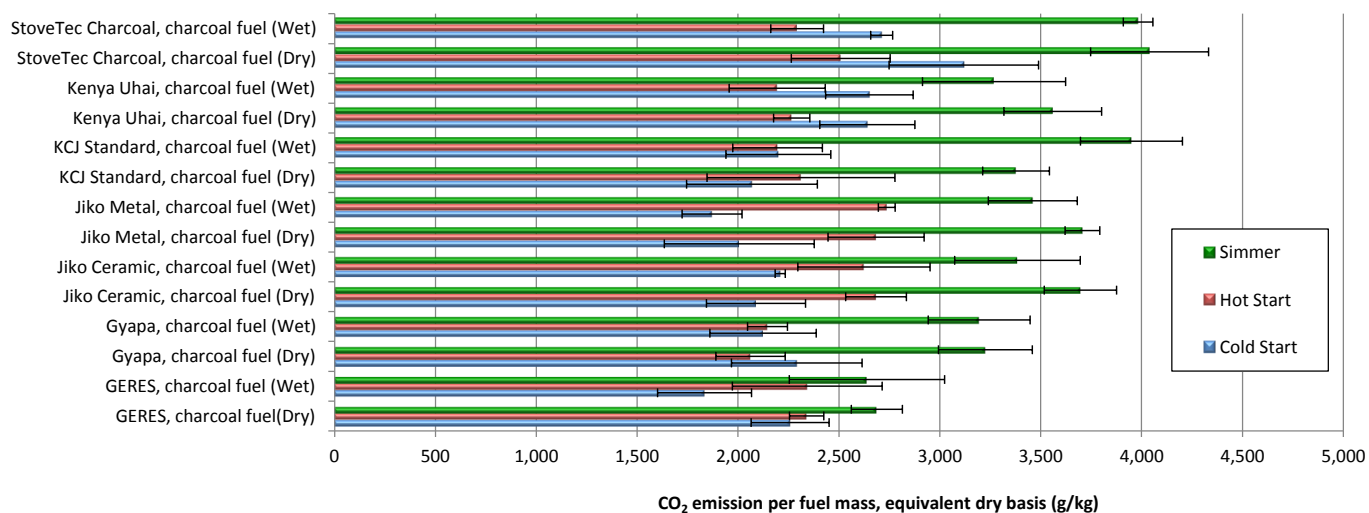
Figure S40. CO₂ Emission per Fuel Mass (Equivalent Dry Basis)
Wood Fuel



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1,504	67	1,413	65	1,758	217
3 Stone carefully tended, wood fuel (Wet)	1,599	126	1,576	134	1,601	58
3 Stone minimally tended, wood fuel (Dry)	1,433	148	1,307	59	1,734	185

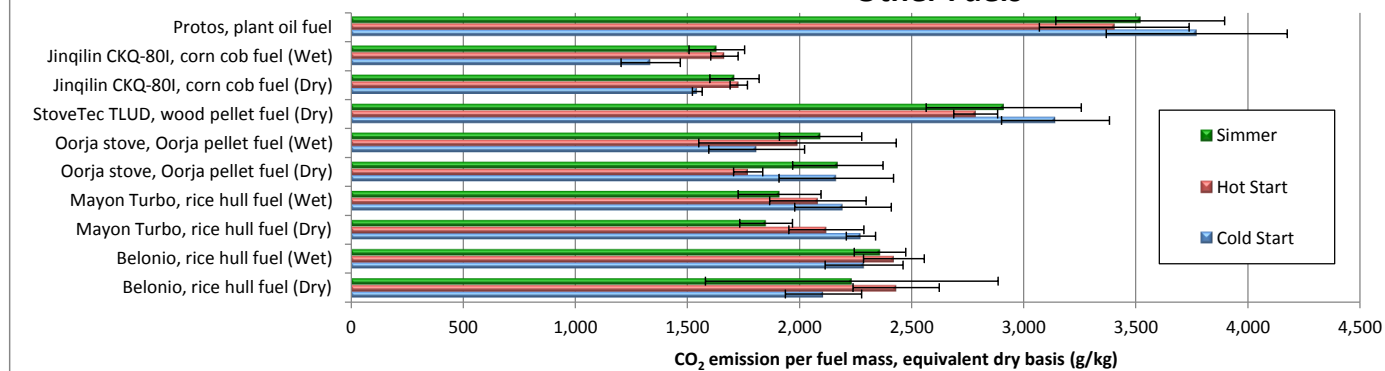
Berkeley Darfur, wood fuel (Dry)	1,725	193	1,810	144	2,043	131
Berkeley Darfur, wood fuel (Wet)	1,634	115	1,776	177	2,175	239
Envirofit G-3300, wood fuel (Dry)	1,644	62	1,649	96	1,852	196
Envirofit G-3300, wood fuel (Wet)	1,739	102	1,766	125	1,887	47
Envirofit G-3300, med. pwr., wood fuel (Dry)	1,746	84	1,747	15	2,021	78
Onil, wood fuel (Dry)	1,899	89	1,950	54	1,928	225
Philips HD4008 Natural Draft, wood fuel (Dry)	1,862	45	1,729	62	1,628	86
Philips HD4008 Natural Draft, wood fuel (Wet)	1,781	42	1,801	101	1,964	184
Philips HD4012 fan, wood fuel (Dry)	1,761	42	1,686	81	2,042	93
Philips HD4012 fan, wood fuel (Wet)	1,987	59	2,080	168	1,909	168
Sampada, wood fuel (Dry)	1,935	24	1,984	180	1,946	262
Sampada, wood fuel (Wet)	2,008	272	2,077	227	2,013	144
StoveTec GreenFire, wood fuel (Dry)	1,595	52	1,464	168	2,137	336
StoveTec GreenFire, wood fuel (Wet)	1,729	72	1,611	76	1,628	63
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1,847	89	1,522	108	1,782	99
Upesi Portable, wood fuel (Dry)	1,734	82	1,783	51	1,585	215
Upesi Portable, wood fuel (Wet)	1,619	306	1,818	112	1,890	97

Figure S41. CO₂ Emission per Fuel Mass (Equivalent Dry Basis) - Charcoal Fuel



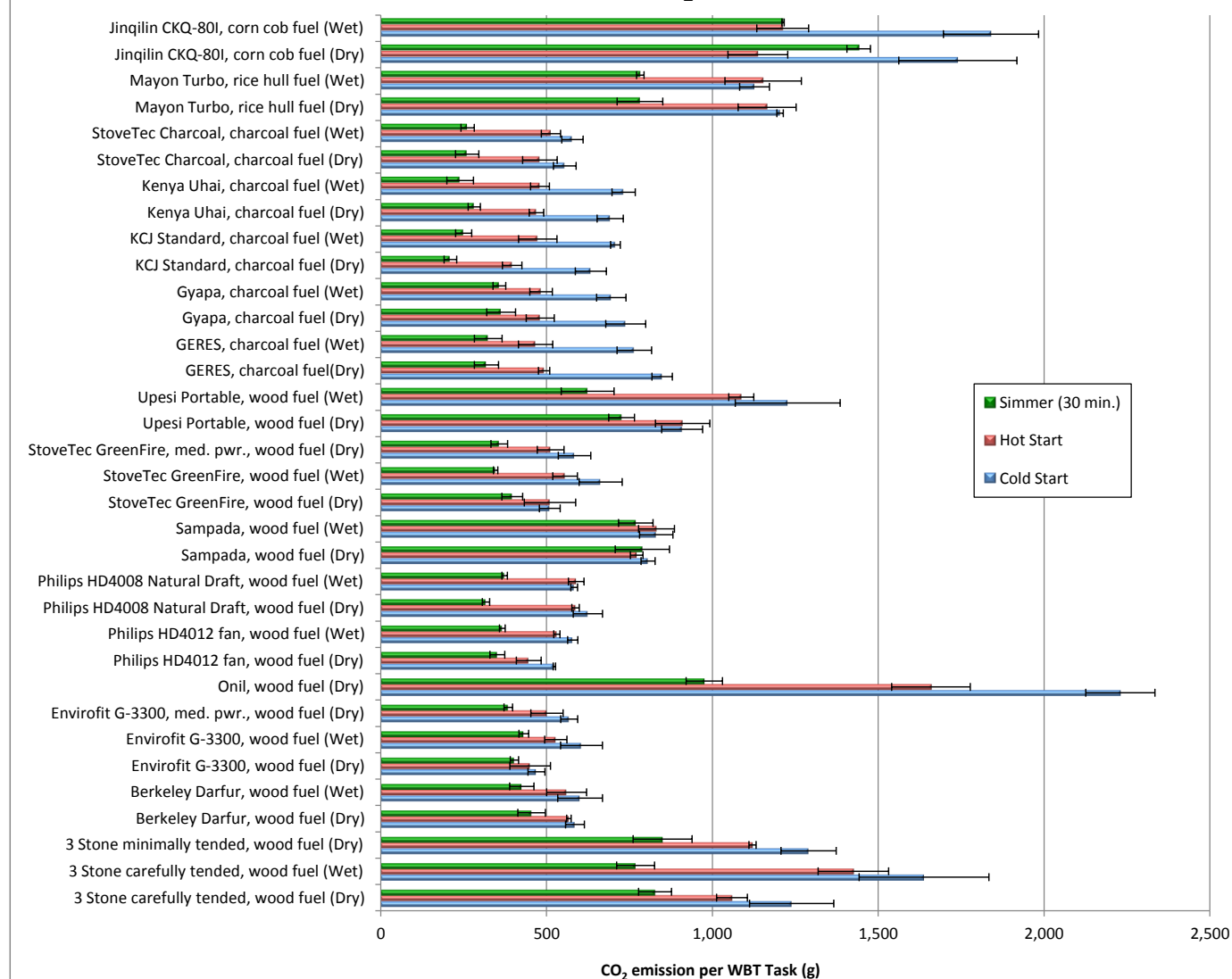
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel(Dry)	2,258	193	2,340	85	2,688	127
GERES, charcoal fuel (Wet)	1,834	233	2,343	371	2,639	385
Gyapa, charcoal fuel (Dry)	2,291	324	2,062	172	3,226	233
Gyapa, charcoal fuel (Wet)	2,124	263	2,146	99	3,195	253
Jiko Ceramic, charcoal fuel (Dry)	2,089	246	2,684	151	3,697	179
Jiko Ceramic, charcoal fuel (Wet)	2,209	25	2,624	328	3,385	311
Jiko Metal, charcoal fuel (Dry)	2,006	372	2,684	238	3,707	86
Jiko Metal, charcoal fuel (Wet)	1,871	149	2,737	42	3,461	221
KCJ Standard, charcoal fuel (Dry)	2,069	324	2,312	466	3,378	165
KCJ Standard, charcoal fuel (Wet)	2,200	260	2,196	222	3,950	253
Kenya Uhai, charcoal fuel (Dry)	2,641	236	2,266	90	3,560	242
Kenya Uhai, charcoal fuel (Wet)	2,651	217	2,194	238	3,269	355
StoveTec Charcoal, charcoal fuel (Dry)	3,119	371	2,509	245	4,040	292
StoveTec Charcoal, charcoal fuel (Wet)	2,712	54	2,293	131	3,983	73

Figure S42. CO₂ Emission per Fuel Mass (Equivalent Dry Basis)
Other Fuels



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	2,107	170	2,431	192	2,233	653
Belonio, rice hull fuel (Wet)	2,288	174	2,421	136	2,359	115
Mayon Turbo, rice hull fuel (Dry)	2,274	65	2,120	167	1,851	118
Mayon Turbo, rice hull fuel (Wet)	2,194	215	2,082	215	1,911	185
Oorja stove, Oorja pellet fuel (Dry)	2,164	256	1,771	65	2,171	202
Oorja stove, Oorja pellet fuel (Wet)	1,809	214	1,991	440	2,094	184
StoveTec TLUD, wood pellet fuel (Dry)	3,142	241	2,786	98	2,911	346
Jinqilin CKQ-80I, corn cob fuel (Dry)	1,544	22	1,729	39	1,710	110
Jinqilin CKQ-80I, corn cob fuel (Wet)	1,336	132	1,665	61	1,631	124
Protos, plant oil fuel	3,772	404	3,404	334	3,520	377

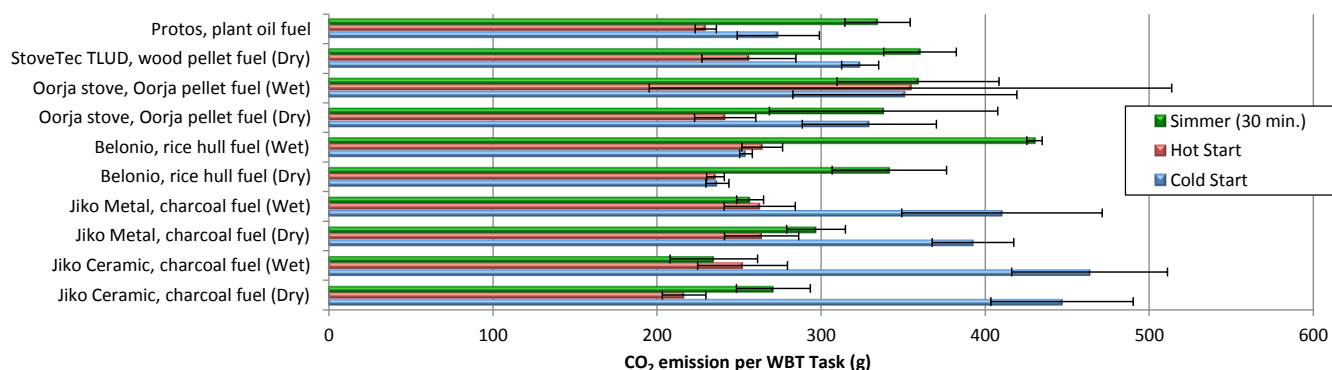
Figure S43. CO₂ Emission per WBT Task - 5 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1,239	127	1,059	46	827	50
3 Stone carefully tended, wood fuel (Wet)	1,638	196	1,425	106	768	57
3 Stone minimally tended, wood fuel (Dry)	1,290	83	1,121	11	850	89
Berkeley Darfur, wood fuel (Dry)	586	28	567	7	455	42
Berkeley Darfur, wood fuel (Wet)	601	68	560	60	425	37
Envirofit G-3300, wood fuel (Dry)	470	26	451	61	403	13
Envirofit G-3300, wood fuel (Wet)	605	63	528	34	431	15
Envirofit G-3300, med. pwr., wood fuel (Dry)	568	25	501	49	385	13
Onil, wood fuel (Dry)	2,230	104	1,659	119	976	55
Philips HD4012 fan, wood fuel (Dry)	524	4	446	37	352	22
Philips HD4012 fan, wood fuel (Wet)	579	15	531	9	367	9
Philips HD4008 Natural Draft, wood fuel (Dry)	625	44	587	11	317	11
Philips HD4008 Natural Draft, wood fuel (Wet)	583	10	589	23	374	8
Sampada, wood fuel (Dry)	806	21	772	19	789	82
Sampada, wood fuel (Wet)	831	50	831	54	769	52
StoveTec GreenFire, wood fuel (Dry)	510	31	510	77	397	31
StoveTec GreenFire, wood fuel (Wet)	663	65	556	37	346	7
StoveTec GreenFire, med. pwr., wood fuel (Dry)	584	49	512	40	357	25
Upesi Portable, wood fuel (Dry)	909	62	910	82	726	39

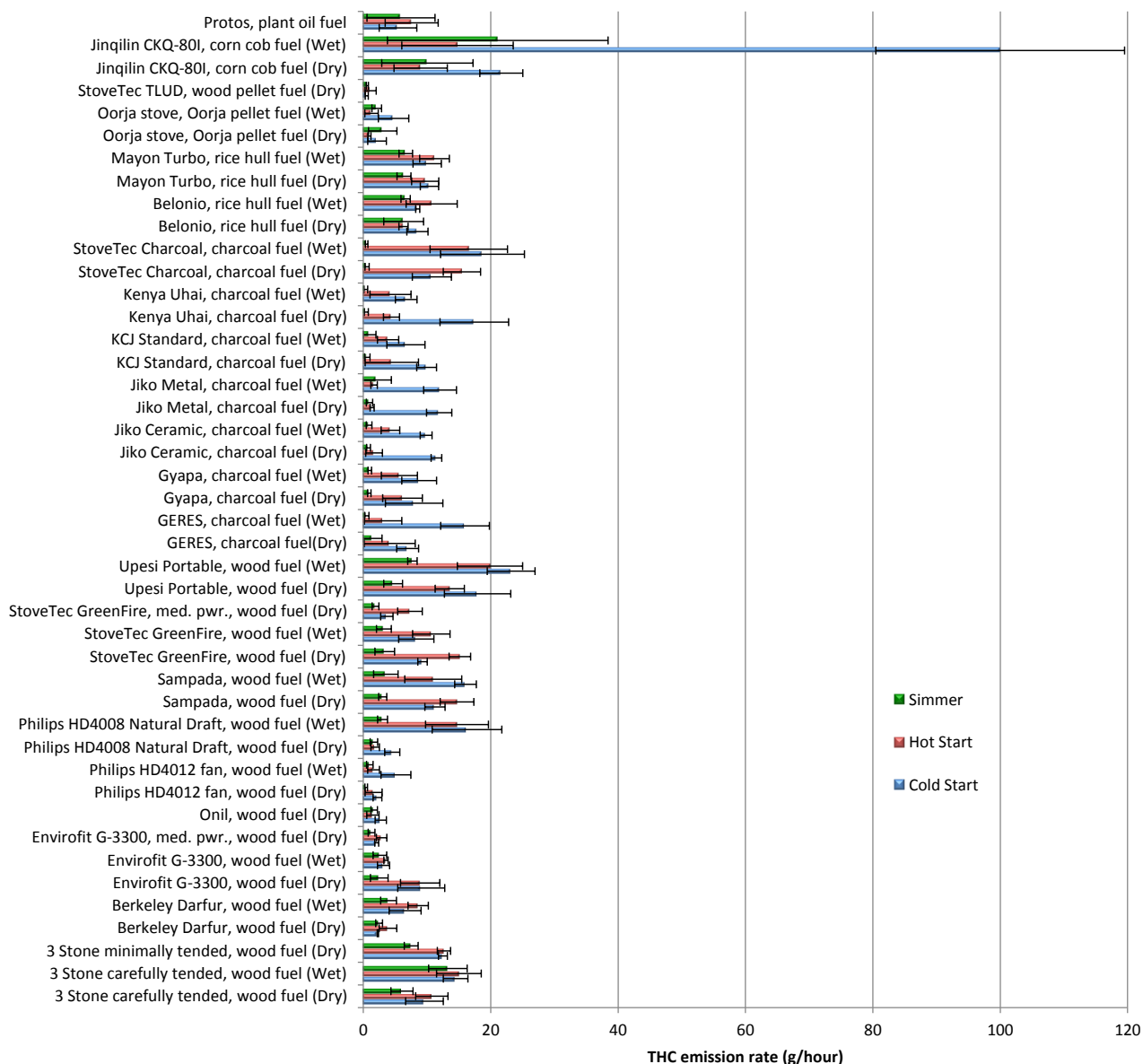
Upesi Portable, wood fuel (Wet)	1,227	158	1,087	38	624	80
GERES, charcoal fuel (Dry)	848	31	493	17	319	36
GERES, charcoal fuel (Wet)	765	52	467	52	324	42
Gyapa, charcoal fuel (Dry)	739	60	481	42	363	43
Gyapa, charcoal fuel (Wet)	695	44	483	34	358	19
KCJ Standard, charcoal fuel (Dry)	633	47	396	29	210	19
KCJ Standard, charcoal fuel (Wet)	708	15	474	58	250	24
Kenya Uhai, charcoal fuel (Dry)	692	39	470	22	282	18
Kenya Uhai, charcoal fuel (Wet)	732	35	480	28	239	40
StoveTec Charcoal, charcoal fuel (Dry)	555	34	480	52	261	35
StoveTec Charcoal, charcoal fuel (Wet)	578	32	513	29	262	20
Mayon Turbo, rice hull fuel (Dry)	1,204	10	1,165	87	782	69
Mayon Turbo, rice hull fuel (Wet)	1,127	45	1,153	115	783	11
Jinqilin CKQ-80I, corn cob fuel (Dry)	1,740	178	1,137	90	1,441	35
Jinqilin CKQ-80I, corn cob fuel (Wet)	1,840	143	1,212	78	1,213	3

Figure S44. CO₂ Emission per WBT Task - 2 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Jiko Ceramic, charcoal fuel (Dry)	447	43	217	13	271	23
Jiko Ceramic, charcoal fuel (Wet)	464	48	252	27	235	27
Jiko Metal, charcoal fuel (Dry)	393	25	264	23	297	18
Jiko Metal, charcoal fuel (Wet)	410	61	263	22	257	8
Belonio, rice hull fuel (Dry)	237	7	236	5	342	35
Belonio, rice hull fuel (Wet)	254	4	264	12	430	5
Oorja stove, Oorja pellet fuel (Dry)	329	41	242	19	338	70
Oorja stove, Oorja pellet fuel (Wet)	351	68	355	159	359	49
StoveTec TLUD, wood pellet fuel (Dry)	324	11	256	29	360	22
Protos, plant oil fuel	274	25	230	6	334	20

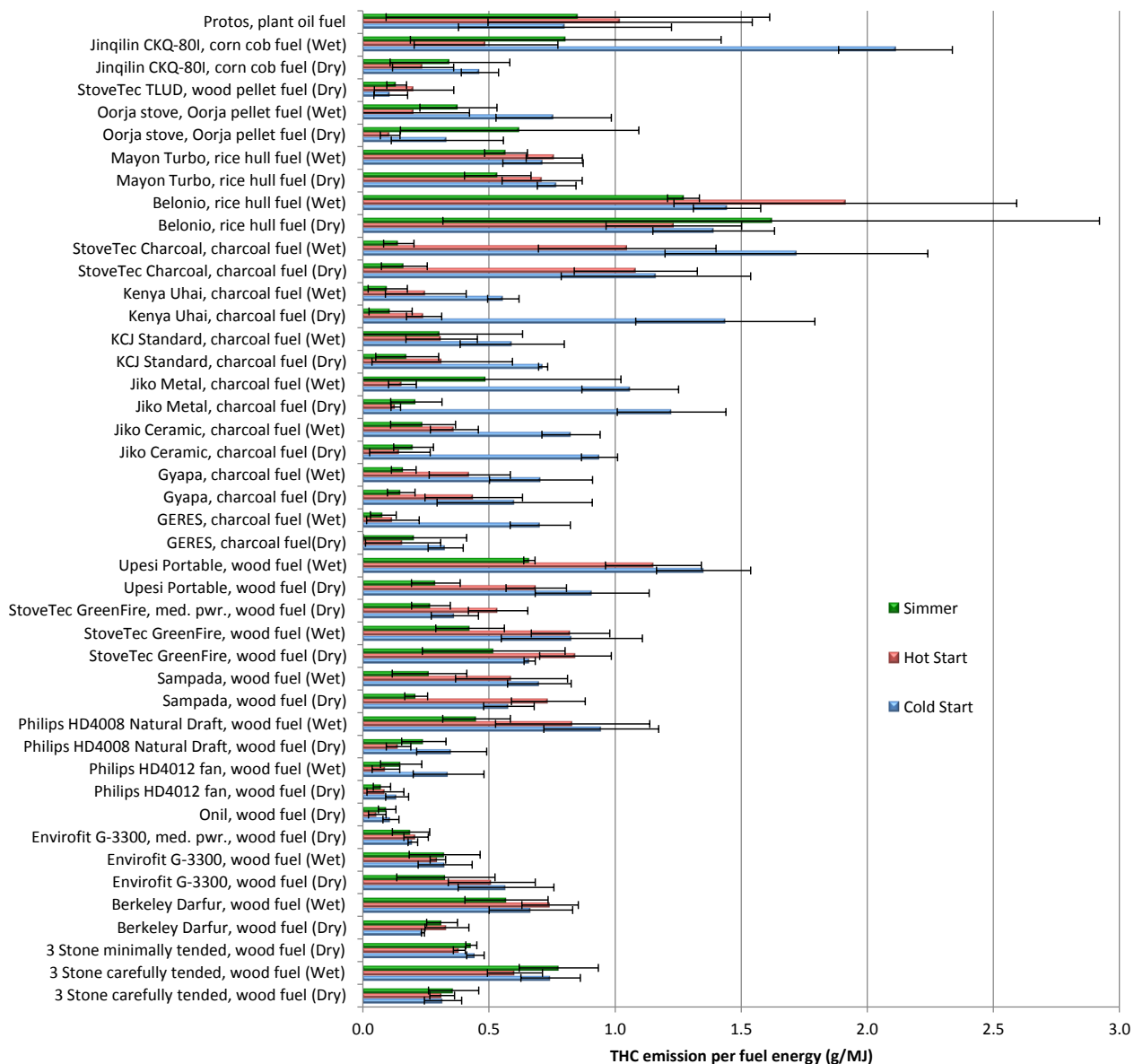
Figure S45. THC Emission Rate (per Time)



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	9.6	3.0	10.8	2.5	6.1	1.7
3 Stone carefully tended, wood fuel (Wet)	14.5	1.9	15.0	3.5	13.3	3.0
3 Stone minimally tended, wood fuel (Dry)	12.5	0.7	12.7	1.0	7.5	1.1
Berkeley Darfur, wood fuel (Dry)	2.3	0.1	3.9	1.4	2.5	0.5
Berkeley Darfur, wood fuel (Wet)	6.6	2.5	8.6	1.6	4.0	1.2
Envirofit G-3300, wood fuel (Dry)	9.1	3.7	8.9	3.1	2.5	1.4
Envirofit G-3300, wood fuel (Wet)	3.2	1.0	3.6	0.3	2.6	1.1
Envirofit G-3300, med. pwr., wood fuel (Dry)	2.1	0.3	2.9	0.8	1.3	0.5
Onil, wood fuel (Dry)	2.7	0.9	1.5	1.0	1.7	0.5
Philips HD4012 fan, wood fuel (Dry)	2.2	0.7	1.6	1.3	0.5	0.2
Philips HD4012 fan, wood fuel (Wet)	5.1	2.3	1.6	0.9	1.0	0.5
Philips HD4008 Natural Draft, wood fuel (Dry)	4.5	1.2	1.9	0.7	1.7	0.6
Philips HD4008 Natural Draft, wood fuel (Wet)	16.3	5.5	14.7	4.9	3.0	0.8
Sampada, wood fuel (Dry)	11.3	1.6	14.7	2.6	3.0	0.6

Sampada, wood fuel (Wet)	16.1	1.7	11.0	4.5	3.5	1.9
StoveTec GreenFire, wood fuel (Dry)	9.3	0.7	15.2	1.7	3.4	1.5
StoveTec GreenFire, wood fuel (Wet)	8.3	2.8	10.7	2.9	3.2	1.2
StoveTec GreenFire, med. pwr., wood fuel (Dry)	3.7	1.0	7.3	1.9	1.9	0.5
Upesi Portable, wood fuel (Dry)	17.9	5.2	13.6	2.3	4.7	1.5
Upesi Portable, wood fuel (Wet)	23.2	3.8	19.9	5.1	7.7	0.7
GERES, charcoal fuel(Dry)	7.0	1.7	4.1	4.0	1.4	1.5
GERES, charcoal fuel (Wet)	16.0	3.8	3.1	2.9	0.6	0.3
Gyapa, charcoal fuel (Dry)	8.0	4.5	6.2	3.1	0.9	0.3
Gyapa, charcoal fuel (Wet)	8.8	2.7	5.7	2.8	1.0	0.3
Jiko Ceramic, charcoal fuel (Dry)	11.5	0.8	1.7	1.3	0.8	0.3
Jiko Ceramic, charcoal fuel (Wet)	9.9	0.9	4.3	1.5	0.9	0.4
Jiko Metal, charcoal fuel (Dry)	11.9	2.0	1.4	0.3	1.0	0.5
Jiko Metal, charcoal fuel (Wet)	12.1	2.6	1.7	0.5	2.1	2.3
KCJ Standard, charcoal fuel (Dry)	9.9	1.6	4.5	4.2	0.6	0.4
KCJ Standard, charcoal fuel (Wet)	6.7	3.0	3.9	1.7	1.0	1.0
Kenya Uhai, charcoal fuel (Dry)	17.4	5.4	4.4	1.3	0.5	0.3
Kenya Uhai, charcoal fuel (Wet)	6.7	1.7	4.3	3.2	0.4	0.3
StoveTec Charcoal, charcoal fuel (Dry)	10.8	3.1	15.5	2.9	0.6	0.3
StoveTec Charcoal, charcoal fuel (Wet)	18.7	6.6	16.6	6.1	0.5	0.2
Belonio, rice hull fuel (Dry)	8.5	1.7	6.3	0.7	6.3	3.1
Belonio, rice hull fuel (Wet)	8.5	0.3	10.7	4.0	6.6	0.7
Mayon Turbo, rice hull fuel (Dry)	10.4	1.4	9.7	2.1	6.4	1.1
Mayon Turbo, rice hull fuel (Wet)	10.0	2.2	11.2	2.3	6.7	1.1
Oorja stove, Oorja pellet fuel (Dry)	2.2	1.5	1.0	0.2	3.1	2.2
Oorja stove, Oorja pellet fuel (Wet)	4.8	2.4	1.3	1.1	2.1	0.8
StoveTec TLUD, wood pellet fuel (Dry)	0.5	0.2	1.2	0.9	0.6	0.2
Jinqilin CKQ-80I, corn cob fuel (Dry)	21.7	3.4	9.0	4.2	10.1	7.2
Jinqilin CKQ-80I, corn cob fuel (Wet)	100.0	19.5	14.8	8.7	21.1	17.3
Protos, plant oil fuel	5.4	3.0	7.6	4.2	5.9	5.3

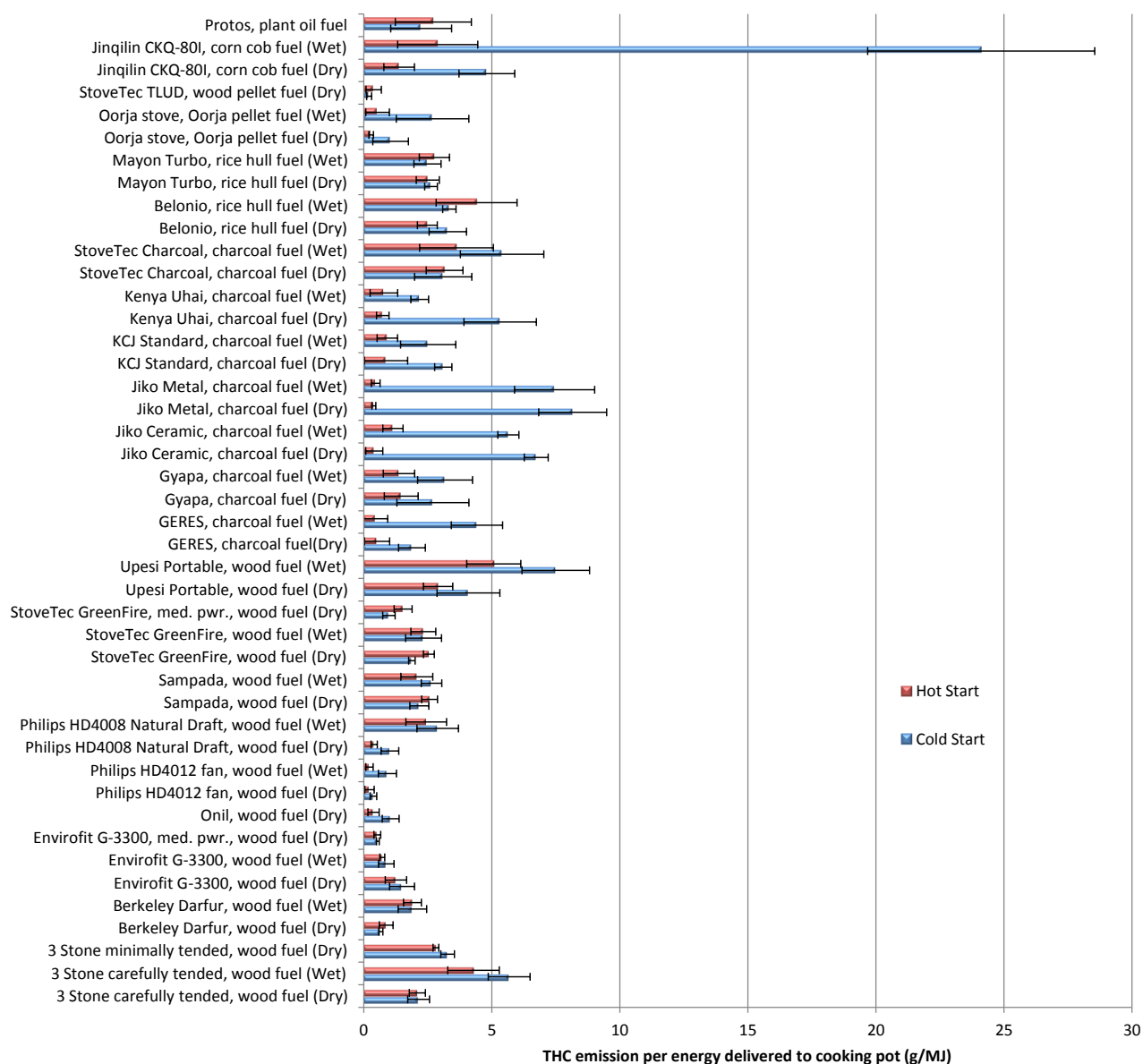
Figure S46. THC Emission per Fuel Energy



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	0.32	0.07	0.31	0.05	0.36	0.10
3 Stone carefully tended, wood fuel (Wet)	0.74	0.12	0.60	0.11	0.78	0.16
3 Stone minimally tended, wood fuel (Dry)	0.45	0.03	0.38	0.02	0.43	0.02
Berkeley Darfur, wood fuel (Dry)	0.24	0.01	0.33	0.09	0.31	0.06
Berkeley Darfur, wood fuel (Wet)	0.67	0.17	0.74	0.11	0.57	0.16
Envirofit G-3300, wood fuel (Dry)	0.57	0.19	0.51	0.17	0.33	0.19
Envirofit G-3300, wood fuel (Wet)	0.33	0.11	0.30	0.03	0.32	0.14
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.20	0.02	0.21	0.05	0.19	0.07
Onil, wood fuel (Dry)	0.11	0.03	0.06	0.03	0.10	0.03
Philips HD4012 fan, wood fuel (Dry)	0.14	0.05	0.09	0.07	0.08	0.03
Philips HD4012 fan, wood fuel (Wet)	0.34	0.14	0.09	0.05	0.15	0.08
Philips HD4008 Natural Draft, wood fuel (Dry)	0.35	0.14	0.14	0.05	0.24	0.09
Philips HD4008 Natural Draft, wood fuel (Wet)	0.95	0.23	0.83	0.31	0.45	0.13
Sampada, wood fuel (Dry)	0.58	0.10	0.74	0.15	0.21	0.05
Sampada, wood fuel (Wet)	0.70	0.13	0.59	0.22	0.26	0.15

StoveTec GreenFire, wood fuel (Dry)	0.66	0.02	0.84	0.14	0.52	0.28
StoveTec GreenFire, wood fuel (Wet)	0.83	0.28	0.82	0.16	0.42	0.14
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.36	0.09	0.54	0.12	0.27	0.08
Upesi Portable, wood fuel (Dry)	0.91	0.23	0.69	0.12	0.29	0.10
Upesi Portable, wood fuel (Wet)	1.35	0.19	1.15	0.19	0.66	0.02
GERES, charcoal fuel(Dry)	0.33	0.07	0.16	0.15	0.21	0.21
GERES, charcoal fuel (Wet)	0.70	0.12	0.12	0.10	0.08	0.05
Gyapa, charcoal fuel (Dry)	0.60	0.31	0.44	0.19	0.15	0.05
Gyapa, charcoal fuel (Wet)	0.71	0.20	0.42	0.16	0.16	0.05
Jiko Ceramic, charcoal fuel (Dry)	0.94	0.07	0.15	0.12	0.20	0.08
Jiko Ceramic, charcoal fuel (Wet)	0.83	0.12	0.36	0.10	0.24	0.13
Jiko Metal, charcoal fuel (Dry)	1.22	0.22	0.13	0.02	0.21	0.10
Jiko Metal, charcoal fuel (Wet)	1.06	0.19	0.16	0.06	0.49	0.53
KCJ Standard, charcoal fuel (Dry)	0.71	0.02	0.31	0.28	0.18	0.12
KCJ Standard, charcoal fuel (Wet)	0.59	0.21	0.31	0.14	0.31	0.33
Kenya Uhai, charcoal fuel (Dry)	1.44	0.36	0.24	0.07	0.11	0.09
Kenya Uhai, charcoal fuel (Wet)	0.56	0.06	0.25	0.16	0.10	0.08
StoveTec Charcoal, charcoal fuel (Dry)	1.16	0.38	1.08	0.24	0.16	0.09
StoveTec Charcoal, charcoal fuel (Wet)	1.72	0.52	1.05	0.35	0.14	0.06
Belonio, rice hull fuel (Dry)	1.39	0.24	1.23	0.27	1.62	1.30
Belonio, rice hull fuel (Wet)	1.44	0.13	1.91	0.68	1.27	0.06
Mayon Turbo, rice hull fuel (Dry)	0.77	0.08	0.71	0.16	0.53	0.13
Mayon Turbo, rice hull fuel (Wet)	0.71	0.16	0.76	0.11	0.57	0.08
Oorja stove, Oorja pellet fuel (Dry)	0.33	0.22	0.11	0.04	0.62	0.47
Oorja stove, Oorja pellet fuel (Wet)	0.76	0.23	0.20	0.22	0.38	0.15
StoveTec TLUD, wood pellet fuel (Dry)	0.11	0.07	0.20	0.16	0.13	0.04
Jinqilin CKQ-80l, corn cob fuel (Dry)	0.46	0.07	0.24	0.12	0.35	0.24
Jinqilin CKQ-80l, corn cob fuel (Wet)	2.11	0.23	0.49	0.29	0.80	0.62
Protos, plant oil fuel	0.80	0.42	1.02	0.52	0.85	0.76

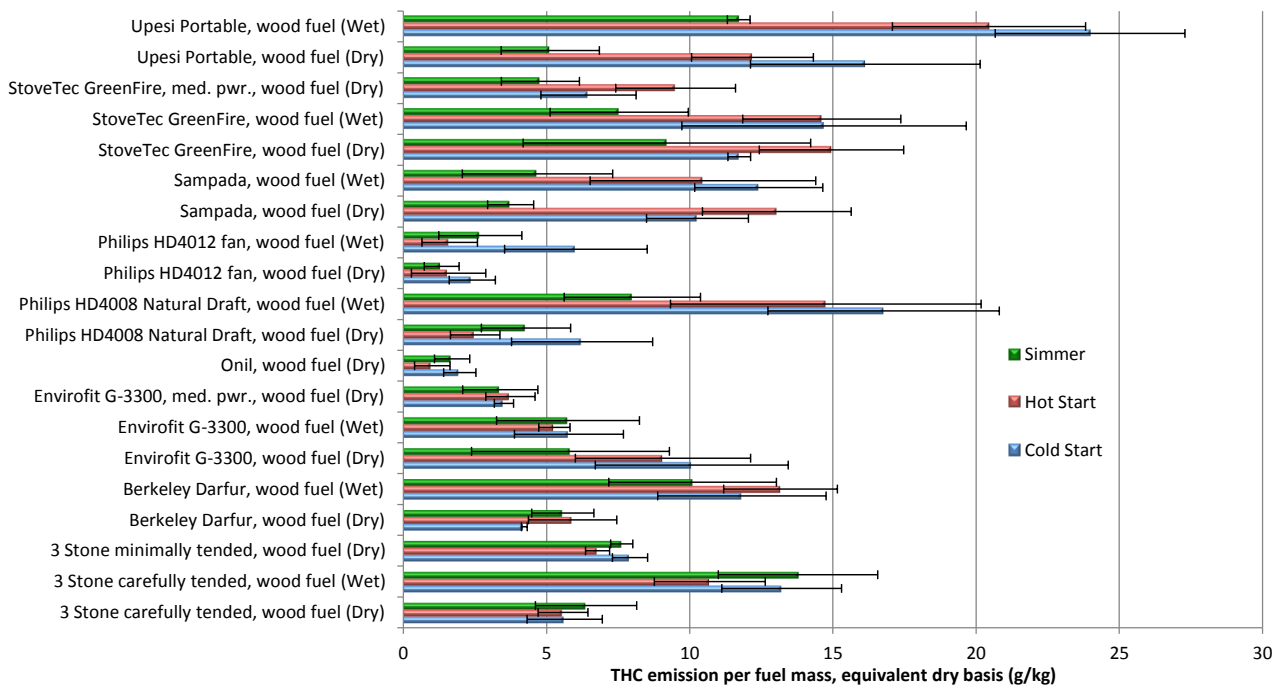
Figure S47. THC Emission per Energy Delivered to Cooking Pot



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	2.1	0.4	2.1	0.3
3 Stone carefully tended, wood fuel (Wet)	5.7	0.8	4.3	1.0
3 Stone minimally tended, wood fuel (Dry)	3.3	0.3	2.8	0.1
Berkeley Darfur, wood fuel (Dry)	0.7	0.1	0.9	0.3
Berkeley Darfur, wood fuel (Wet)	1.9	0.6	1.9	0.3
Envirofit G-3300, wood fuel (Dry)	1.5	0.5	1.3	0.4
Envirofit G-3300, wood fuel (Wet)	0.9	0.3	0.7	0.1
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.5	0.1	0.5	0.1
Onil, wood fuel (Dry)	1.0	0.3	0.4	0.2
Philips HD4012 fan, wood fuel (Dry)	0.4	0.1	0.2	0.2
Philips HD4012 fan, wood fuel (Wet)	0.9	0.4	0.2	0.1
Philips HD4008 Natural Draft, wood fuel (Dry)	1.0	0.3	0.4	0.1
Philips HD4008 Natural Draft, wood fuel (Wet)	2.9	0.8	2.4	0.8
Sampada, wood fuel (Dry)	2.2	0.4	2.6	0.3
Sampada, wood fuel (Wet)	2.6	0.4	2.1	0.6

StoveTec GreenFire, wood fuel (Dry)	1.9	0.1	2.5	0.2
StoveTec GreenFire, wood fuel (Wet)	2.3	0.7	2.3	0.5
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1.0	0.2	1.5	0.4
Upesi Portable, wood fuel (Dry)	4.1	1.2	2.9	0.6
Upesi Portable, wood fuel (Wet)	7.5	1.3	5.1	1.1
GERES, charcoal fuel(Dry)	1.9	0.5	0.5	0.5
GERES, charcoal fuel (Wet)	4.4	1.0	0.5	0.5
Gyapa, charcoal fuel (Dry)	2.7	1.4	1.5	0.7
Gyapa, charcoal fuel (Wet)	3.2	1.1	1.4	0.6
Jiko Ceramic, charcoal fuel (Dry)	6.7	0.5	0.4	0.3
Jiko Ceramic, charcoal fuel (Wet)	5.6	0.4	1.1	0.4
Jiko Metal, charcoal fuel (Dry)	8.2	1.3	0.4	0.1
Jiko Metal, charcoal fuel (Wet)	7.5	1.6	0.5	0.2
KCJ Standard, charcoal fuel (Dry)	3.1	0.3	0.9	0.8
KCJ Standard, charcoal fuel (Wet)	2.5	1.1	0.9	0.4
Kenya Uhai, charcoal fuel (Dry)	5.3	1.4	0.7	0.2
Kenya Uhai, charcoal fuel (Wet)	2.2	0.3	0.8	0.5
StoveTec Charcoal, charcoal fuel (Dry)	3.1	1.1	3.2	0.7
StoveTec Charcoal, charcoal fuel (Wet)	5.4	1.6	3.6	1.4
Belonio, rice hull fuel (Dry)	3.3	0.7	2.5	0.4
Belonio, rice hull fuel (Wet)	3.3	0.3	4.4	1.6
Mayon Turbo, rice hull fuel (Dry)	2.6	0.2	2.5	0.5
Mayon Turbo, rice hull fuel (Wet)	2.5	0.5	2.8	0.6
Oorja stove, Oorja pellet fuel (Dry)	1.0	0.7	0.3	0.1
Oorja stove, Oorja pellet fuel (Wet)	2.7	1.4	0.5	0.5
StoveTec TLUD, wood pellet fuel (Dry)	0.2	0.1	0.4	0.3
Jinqilin CKQ-80l, corn cob fuel (Dry)	4.8	1.1	1.4	0.6
Jinqilin CKQ-80l, corn cob fuel (Wet)	24.1	4.4	2.9	1.6
Protos, plant oil fuel	2.2	1.2	2.7	1.5

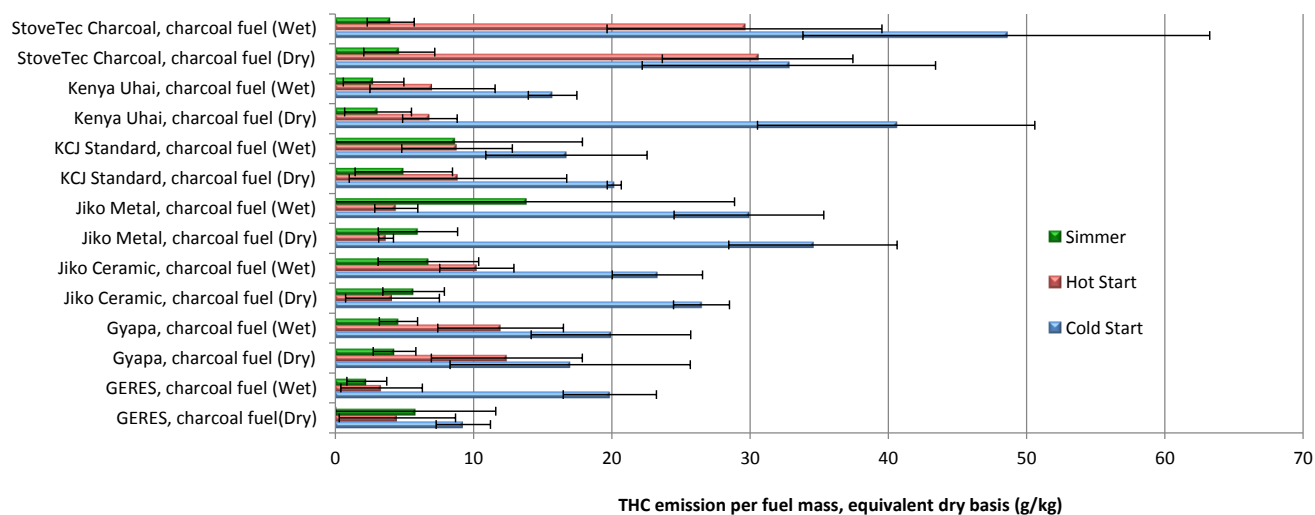
Figure S48. THC Emission per Fuel Mass (Equivalent Dry Basis)
Wood Fuel



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	5.6	1.3	5.6	0.9	6.4	1.8
3 Stone carefully tended, wood fuel (Wet)	13.2	2.1	10.7	1.9	13.8	2.8
3 Stone minimally tended, wood fuel (Dry)	7.9	0.6	6.8	0.4	7.6	0.4

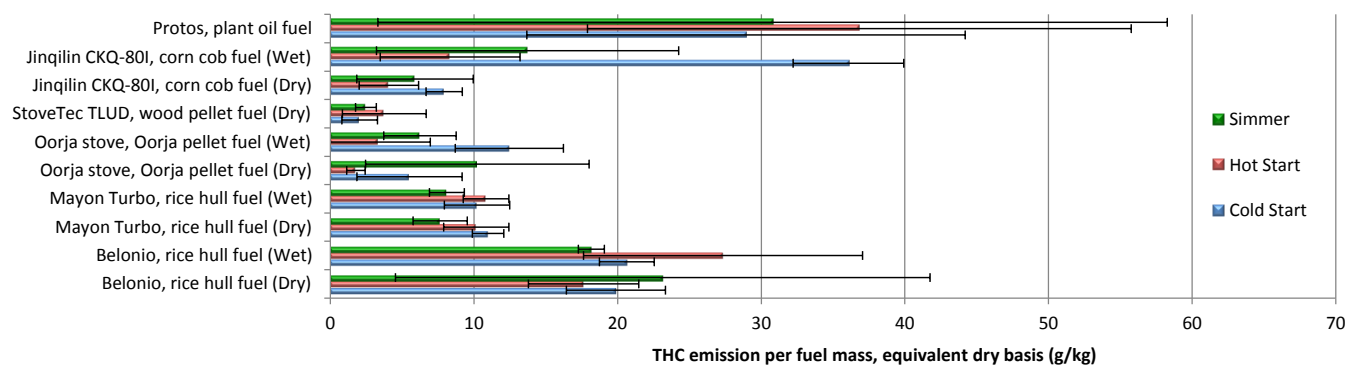
Berkeley Darfur, wood fuel (Dry)	4.2	0.1	5.9	1.5	5.6	1.1
Berkeley Darfur, wood fuel (Wet)	11.8	2.9	13.2	2.0	10.1	2.9
Envirofit G-3300, wood fuel (Dry)	10.1	3.4	9.1	3.1	5.8	3.5
Envirofit G-3300, wood fuel (Wet)	5.8	1.9	5.3	0.5	5.7	2.5
Envirofit G-3300, med. pwr., wood fuel (Dry)	3.5	0.3	3.7	0.9	3.4	1.3
Onil, wood fuel (Dry)	2.0	0.6	1.0	0.6	1.7	0.6
Philips HD4008 Natural Draft, wood fuel (Dry)	6.2	2.5	2.5	0.9	4.3	1.6
Philips HD4008 Natural Draft, wood fuel (Wet)	16.8	4.0	14.8	5.4	8.0	2.4
Philips HD4012 fan, wood fuel (Dry)	2.4	0.8	1.6	1.3	1.3	0.6
Philips HD4012 fan, wood fuel (Wet)	6.0	2.5	1.6	1.0	2.7	1.5
Sampada, wood fuel (Dry)	10.3	1.8	13.0	2.6	3.7	0.8
Sampada, wood fuel (Wet)	12.4	2.2	10.5	3.9	4.7	2.6
StoveTec GreenFire, wood fuel (Dry)	11.7	0.4	15.0	2.5	9.2	5.0
StoveTec GreenFire, wood fuel (Wet)	14.7	5.0	14.6	2.8	7.5	2.4
StoveTec GreenFire, med. pwr., wood fuel (Dry)	6.5	1.7	9.5	2.1	4.8	1.4
Upesi Portable, wood fuel (Dry)	16.1	4.0	12.2	2.1	5.1	1.7
Upesi Portable, wood fuel (Wet)	24.0	3.3	20.5	3.4	11.7	0.4

Figure S49. THC Emission per Fuel Mass (Equivalent Dry Basis)
Charcoal Fuel



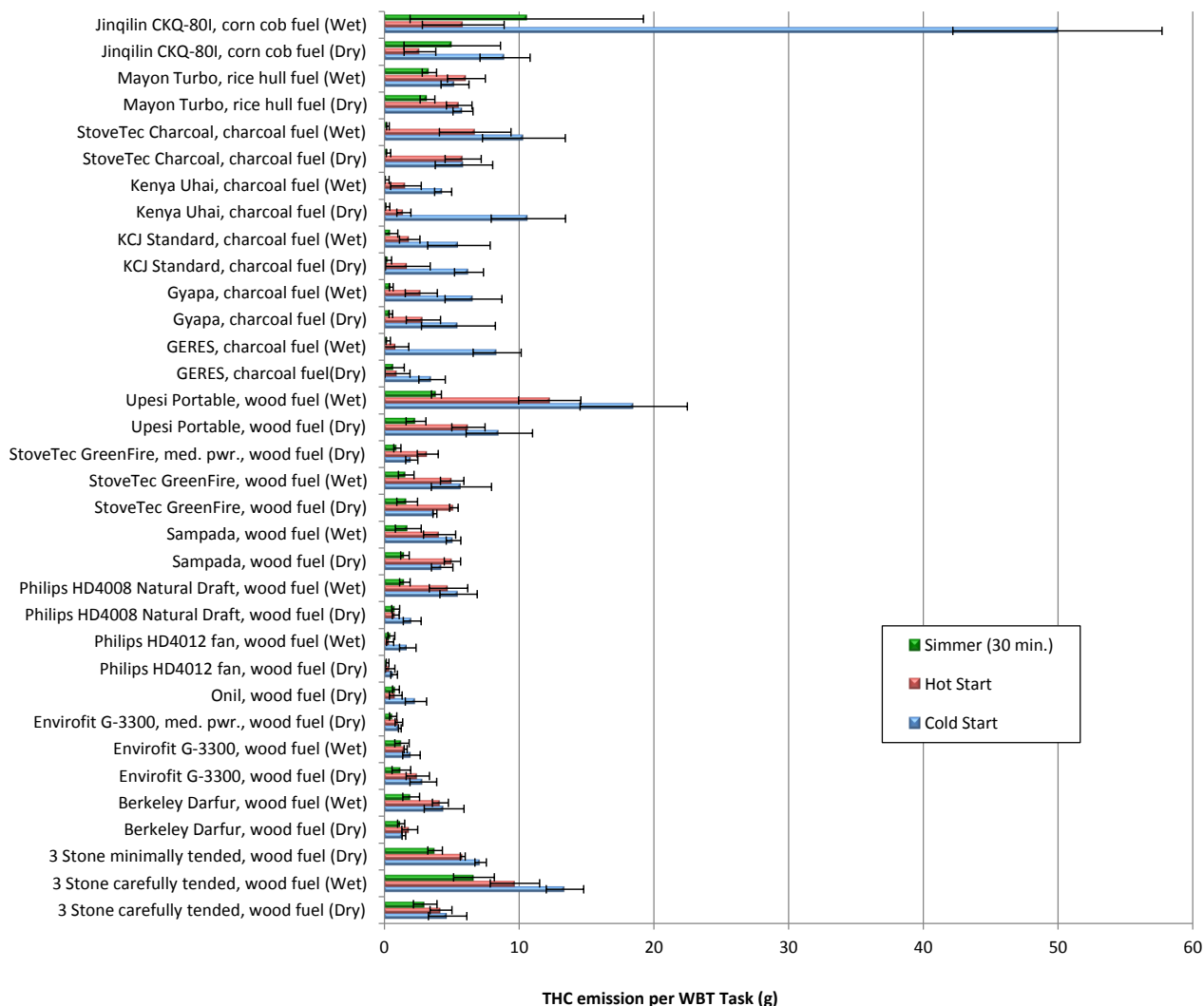
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel(Dry)	9.3	2.0	4.5	4.2	5.8	5.8
GERES, charcoal fuel (Wet)	19.9	3.4	3.4	2.9	2.3	1.4
Gyapa, charcoal fuel (Dry)	17.0	8.7	12.4	5.5	4.3	1.5
Gyapa, charcoal fuel (Wet)	19.9	5.8	12.0	4.5	4.6	1.4
Jiko Ceramic, charcoal fuel (Dry)	26.5	2.0	4.1	3.4	5.7	2.2
Jiko Ceramic, charcoal fuel (Wet)	23.3	3.3	10.2	2.7	6.7	3.6
Jiko Metal, charcoal fuel (Dry)	34.6	6.1	3.7	0.5	6.0	2.9
Jiko Metal, charcoal fuel (Wet)	29.9	5.4	4.4	1.6	13.8	15.1
KCJ Standard, charcoal fuel (Dry)	20.2	0.5	8.9	7.9	5.0	3.5
KCJ Standard, charcoal fuel (Wet)	16.7	5.8	8.8	4.0	8.7	9.2
Kenya Uhai, charcoal fuel (Dry)	40.6	10.0	6.8	2.0	3.1	2.4
Kenya Uhai, charcoal fuel (Wet)	15.7	1.8	7.0	4.5	2.8	2.2
StoveTec Charcoal, charcoal fuel (Dry)	32.8	10.6	30.6	6.9	4.6	2.6
StoveTec Charcoal, charcoal fuel (Wet)	48.5	14.7	29.6	9.9	4.0	1.7

Figure S50. THC Emission per Fuel Mass (Equivalent Dry Basis)
Other Fuels



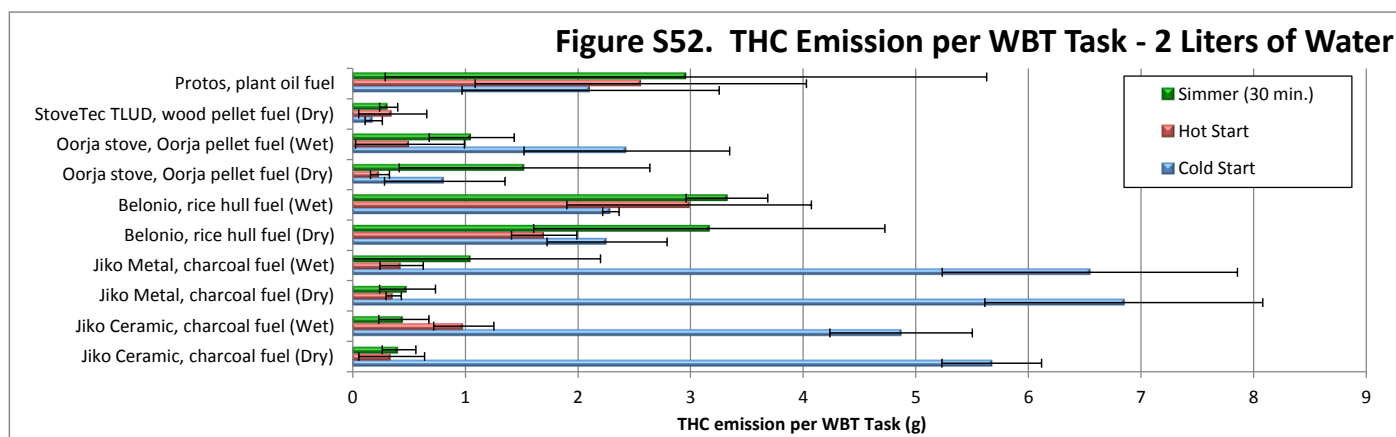
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	19.9	3.4	17.6	3.8	23.1	18.6
Belonio, rice hull fuel (Wet)	20.6	1.9	27.3	9.7	18.2	0.9
Mayon Turbo, rice hull fuel (Dry)	11.0	1.1	10.2	2.3	7.6	1.9
Mayon Turbo, rice hull fuel (Wet)	10.2	2.3	10.8	1.6	8.1	1.2
Oorja stove, Oorja pellet fuel (Dry)	5.5	3.7	1.8	0.6	10.2	7.8
Oorja stove, Oorja pellet fuel (Wet)	12.5	3.8	3.4	3.6	6.2	2.5
StoveTec TLUD, wood pellet fuel (Dry)	2.0	1.2	3.8	2.9	2.5	0.7
Jinqilin CKQ-80I, corn cob fuel (Dry)	7.9	1.3	4.1	2.1	5.9	4.1
Jinqilin CKQ-80I, corn cob fuel (Wet)	36.1	3.9	8.3	4.9	13.7	10.5
Protos, plant oil fuel	28.9	15.3	36.8	18.9	30.8	27.5

Figure S51. THC Emission per WBT Task - 5 Liters of Water



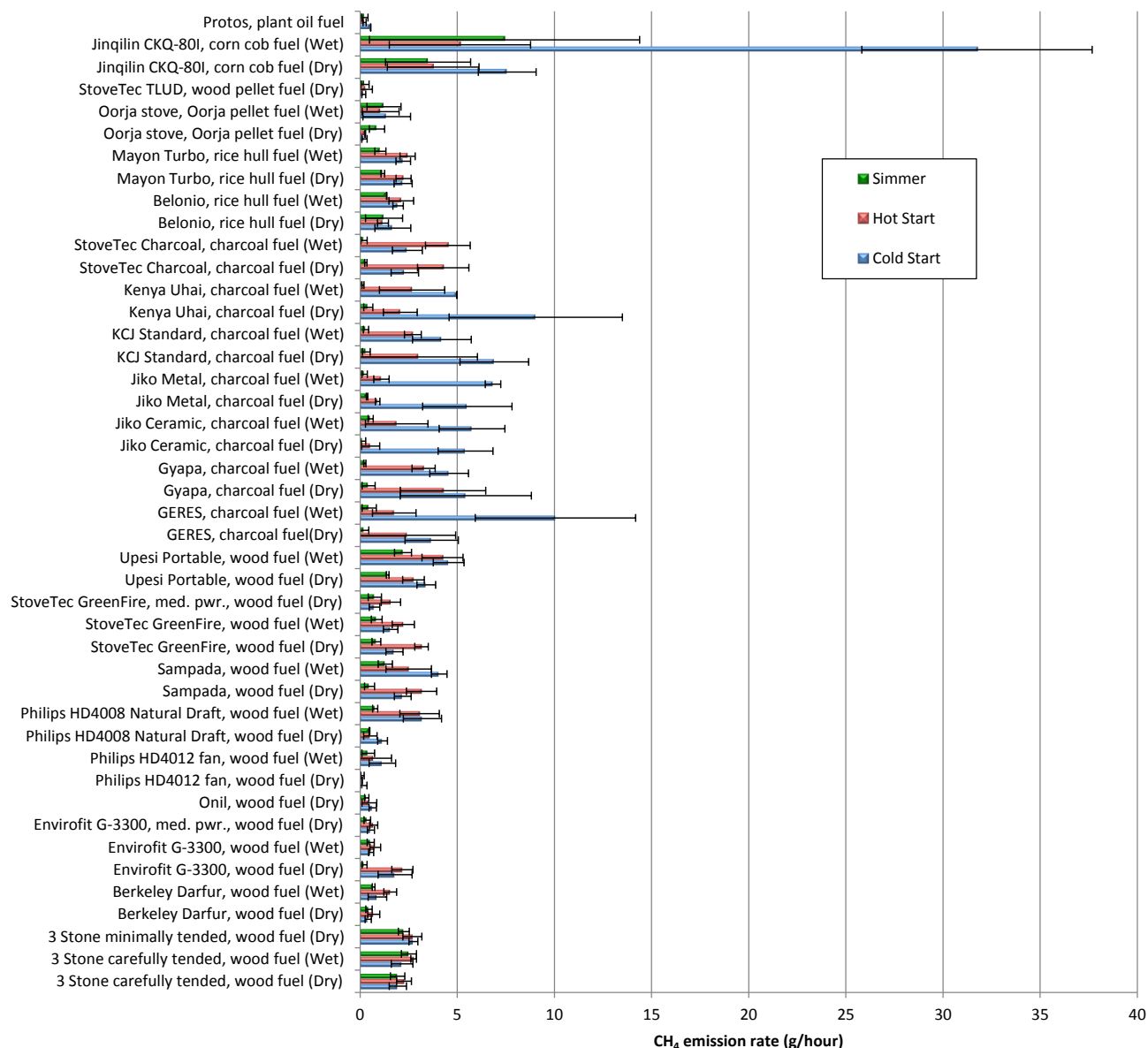
	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	4.7	1.4	4.2	0.8	3.0	0.9
3 Stone carefully tended, wood fuel (Wet)	13.4	1.4	9.7	1.8	6.6	1.5
3 Stone minimally tended, wood fuel (Dry)	7.1	0.4	5.8	0.2	3.8	0.5
Berkeley Darfur, wood fuel (Dry)	1.4	0.1	1.9	0.6	1.2	0.3
Berkeley Darfur, wood fuel (Wet)	4.4	1.5	4.2	0.6	2.0	0.6
Envirofit G-3300, wood fuel (Dry)	2.9	1.0	2.5	0.9	1.3	0.7
Envirofit G-3300, wood fuel (Wet)	2.0	0.6	1.6	0.1	1.3	0.5
Envirofit G-3300, med. pwr., wood fuel (Dry)	1.1	0.1	1.1	0.3	0.6	0.3
Onil, wood fuel (Dry)	2.3	0.8	0.8	0.5	0.9	0.3
Philips HD4012 fan, wood fuel (Dry)	0.7	0.2	0.4	0.4	0.2	0.1
Philips HD4012 fan, wood fuel (Wet)	1.7	0.6	0.4	0.3	0.5	0.3
Philips HD4008 Natural Draft, wood fuel (Dry)	2.1	0.7	0.8	0.3	0.8	0.3
Philips HD4008 Natural Draft, wood fuel (Wet)	5.5	1.4	4.8	1.4	1.5	0.4
Sampada, wood fuel (Dry)	4.3	0.8	5.0	0.6	1.5	0.3
Sampada, wood fuel (Wet)	5.1	0.5	4.1	1.2	1.8	1.0
StoveTec GreenFire, wood fuel (Dry)	3.7	0.1	5.1	0.3	1.7	0.8
StoveTec GreenFire, wood fuel (Wet)	5.7	2.2	5.0	0.9	1.6	0.6
StoveTec GreenFire, med. pwr., wood fuel (Dry)	2.0	0.4	3.2	0.8	1.0	0.3
Upesi Portable, wood fuel (Dry)	8.5	2.5	6.2	1.2	2.3	0.7
Upesi Portable, wood fuel (Wet)	18.5	4.0	12.3	2.3	3.9	0.4

GERES, charcoal fuel(Dry)	3.5	1.0	1.0	0.9	0.7	0.8
GERES, charcoal fuel (Wet)	8.4	1.8	0.9	0.9	0.3	0.2
Gyapa, charcoal fuel (Dry)	5.5	2.7	2.9	1.3	0.5	0.1
Gyapa, charcoal fuel (Wet)	6.6	2.1	2.7	1.2	0.5	0.1
KCJ Standard, charcoal fuel (Dry)	6.3	1.1	1.7	1.7	0.3	0.2
KCJ Standard, charcoal fuel (Wet)	5.5	2.3	1.9	0.8	0.5	0.5
Kenya Uhai, charcoal fuel (Dry)	10.7	2.8	1.4	0.5	0.2	0.2
Kenya Uhai, charcoal fuel (Wet)	4.4	0.6	1.6	1.1	0.2	0.1
StoveTec Charcoal, charcoal fuel (Dry)	5.9	2.1	5.8	1.3	0.3	0.2
StoveTec Charcoal, charcoal fuel (Wet)	10.4	3.1	6.7	2.7	0.3	0.1
Mayon Turbo, rice hull fuel (Dry)	5.8	0.7	5.5	0.9	3.2	0.5
Mayon Turbo, rice hull fuel (Wet)	5.2	1.0	6.1	1.4	3.3	0.5
Jinqilin CKQ-80I, corn cob fuel (Dry)	9.0	1.9	2.6	1.2	5.0	3.6
Jinqilin CKQ-80I, corn cob fuel (Wet)	50.0	7.8	5.9	3.0	10.6	8.7



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Jiko Ceramic, charcoal fuel (Dry)	5.7	0.4	0.3	0.3	0.4	0.1
Jiko Ceramic, charcoal fuel (Wet)	4.9	0.6	1.0	0.3	0.5	0.2
Jiko Metal, charcoal fuel (Dry)	6.8	1.2	0.4	0.1	0.5	0.2
Jiko Metal, charcoal fuel (Wet)	6.5	1.3	0.4	0.2	1.1	1.1
Belonio, rice hull fuel (Dry)	2.3	0.5	1.7	0.3	3.2	1.6
Belonio, rice hull fuel (Wet)	2.3	0.1	3.0	1.1	3.3	0.4
Oorja stove, Oorja pellet fuel (Dry)	0.8	0.5	0.2	0.1	1.5	1.1
Oorja stove, Oorja pellet fuel (Wet)	2.4	0.9	0.5	0.5	1.1	0.4
StoveTec TLUD, wood pellet fuel (Dry)	0.2	0.1	0.4	0.3	0.3	0.1
Protos, plant oil fuel	2.1	1.1	2.6	1.5	3.0	2.7

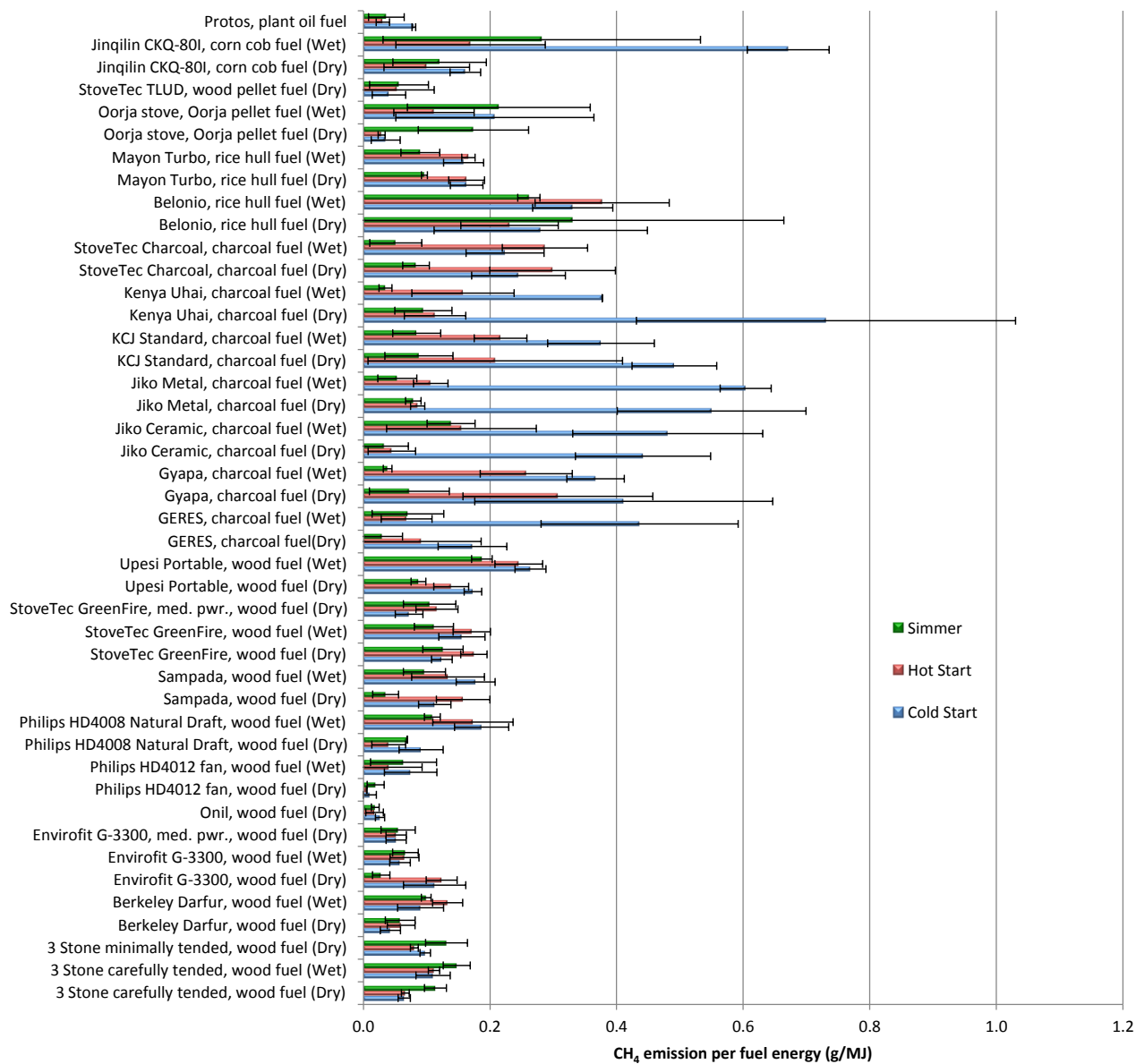
Figure S53. CH₄ Emission Rate (per Time)



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1.9	0.4	2.3	0.4	1.9	0.4
3 Stone carefully tended, wood fuel (Wet)	2.2	0.6	2.8	0.1	2.5	0.4
3 Stone minimally tended, wood fuel (Dry)	2.7	0.2	2.7	0.5	2.2	0.3
Berkeley Darfur, wood fuel (Dry)	0.4	0.2	0.7	0.3	0.5	0.2
Berkeley Darfur, wood fuel (Wet)	0.9	0.5	1.5	0.3	0.7	0.1
Envirofit G-3300, wood fuel (Dry)	1.8	0.9	2.2	0.5	0.2	0.1
Envirofit G-3300, wood fuel (Wet)	0.6	0.1	0.8	0.3	0.5	0.2
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.6	0.2	0.7	0.2	0.4	0.2
Onil, wood fuel (Dry)	0.6	0.2	0.5	0.4	0.3	0.1
Philips HD4012 fan, wood fuel (Dry)	0.2	0.2	0.1	0.0	0.1	0.1
Philips HD4012 fan, wood fuel (Wet)	1.1	0.7	0.7	0.9	0.4	0.3
Philips HD4008 Natural Draft, wood fuel (Dry)	1.2	0.3	0.5	0.3	0.5	0.0
Philips HD4008 Natural Draft, wood fuel (Wet)	3.2	1.0	3.1	1.0	0.8	0.1
Sampada, wood fuel (Dry)	2.2	0.4	3.2	0.8	0.5	0.3

Sampada, wood fuel (Wet)	4.1	0.4	2.5	1.2	1.3	0.4
StoveTec GreenFire, wood fuel (Dry)	1.8	0.4	3.2	0.3	0.8	0.2
StoveTec GreenFire, wood fuel (Wet)	1.6	0.4	2.2	0.6	0.9	0.3
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.7	0.3	1.6	0.5	0.8	0.3
Upesi Portable, wood fuel (Dry)	3.4	0.5	2.7	0.6	1.4	0.1
Upesi Portable, wood fuel (Wet)	4.6	0.8	4.2	1.1	2.2	0.4
GERES, charcoal fuel(Dry)	3.7	1.4	2.4	2.5	0.2	0.2
GERES, charcoal fuel (Wet)	10.1	4.1	1.8	1.1	0.5	0.4
Gyapa, charcoal fuel (Dry)	5.4	3.4	4.3	2.2	0.4	0.3
Gyapa, charcoal fuel (Wet)	4.6	1.0	3.3	0.6	0.2	0.0
Jiko Ceramic, charcoal fuel (Dry)	5.4	1.4	0.5	0.5	0.1	0.2
Jiko Ceramic, charcoal fuel (Wet)	5.8	1.7	1.9	1.6	0.5	0.1
Jiko Metal, charcoal fuel (Dry)	5.5	2.3	0.9	0.1	0.4	0.0
Jiko Metal, charcoal fuel (Wet)	6.8	0.4	1.1	0.4	0.2	0.1
KCJ Standard, charcoal fuel (Dry)	6.9	1.8	3.0	3.1	0.3	0.2
KCJ Standard, charcoal fuel (Wet)	4.2	1.5	2.7	0.4	0.3	0.1
Kenya Uhai, charcoal fuel (Dry)	9.0	4.5	2.1	0.9	0.4	0.2
Kenya Uhai, charcoal fuel (Wet)	5.0	0.0	2.7	1.7	0.1	0.1
StoveTec Charcoal, charcoal fuel (Dry)	2.3	0.7	4.3	1.3	0.3	0.1
StoveTec Charcoal, charcoal fuel (Wet)	2.4	0.8	4.5	1.2	0.2	0.2
Belonio, rice hull fuel (Dry)	1.7	0.9	1.2	0.3	1.2	1.0
Belonio, rice hull fuel (Wet)	2.0	0.3	2.1	0.6	1.4	0.0
Mayon Turbo, rice hull fuel (Dry)	2.2	0.5	2.2	0.4	1.2	0.1
Mayon Turbo, rice hull fuel (Wet)	2.2	0.4	2.4	0.4	1.0	0.3
Oorja stove, Oorja pellet fuel (Dry)	0.2	0.1	0.3	0.0	0.9	0.4
Oorja stove, Oorja pellet fuel (Wet)	1.4	1.2	1.1	1.0	1.2	0.9
StoveTec TLUD, wood pellet fuel (Dry)	0.2	0.1	0.3	0.3	0.3	0.2
Jinqilin CKQ-80I, corn cob fuel (Dry)	7.6	1.5	3.8	2.4	3.5	2.2
Jinqilin CKQ-80I, corn cob fuel (Wet)	31.8	5.9	5.1	3.6	7.4	7.0
Protos, plant oil fuel	0.5	0.0	0.2	0.1	0.2	0.2

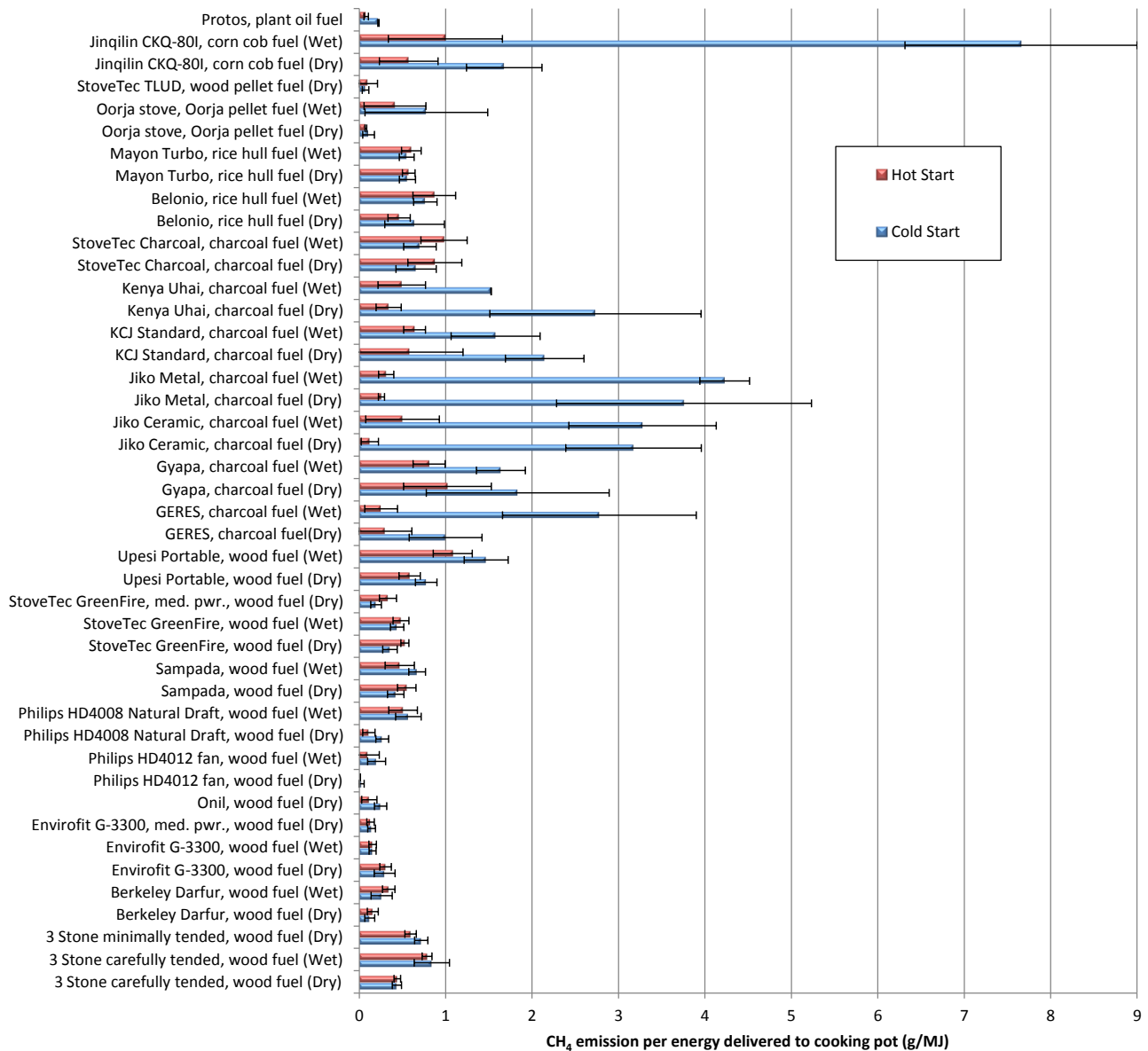
Figure S54. CH₄ Emission per Fuel Energy



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	0.06	0.01	0.07	0.01	0.11	0.02
3 Stone carefully tended, wood fuel (Wet)	0.11	0.03	0.11	0.01	0.15	0.02
3 Stone minimally tended, wood fuel (Dry)	0.10	0.01	0.08	0.01	0.13	0.03
Berkeley Darfur, wood fuel (Dry)	0.04	0.02	0.06	0.02	0.06	0.02
Berkeley Darfur, wood fuel (Wet)	0.09	0.04	0.13	0.02	0.10	0.01
Envirofit G-3300, wood fuel (Dry)	0.11	0.05	0.12	0.02	0.03	0.01
Envirofit G-3300, wood fuel (Wet)	0.06	0.02	0.06	0.02	0.07	0.02
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.05	0.02	0.05	0.02	0.05	0.03
Onil, wood fuel (Dry)	0.03	0.01	0.02	0.01	0.02	0.01
Philips HD4012 fan, wood fuel (Dry)	0.01	0.01	0.01	0.00	0.02	0.01
Philips HD4012 fan, wood fuel (Wet)	0.07	0.04	0.04	0.05	0.06	0.05
Philips HD4008 Natural Draft, wood fuel (Dry)	0.09	0.03	0.04	0.03	0.07	0.00
Philips HD4008 Natural Draft, wood fuel (Wet)	0.19	0.04	0.17	0.06	0.11	0.01
Sampada, wood fuel (Dry)	0.11	0.03	0.16	0.04	0.04	0.02
Sampada, wood fuel (Wet)	0.18	0.03	0.13	0.06	0.10	0.03

StoveTec GreenFire, wood fuel (Dry)	0.12	0.02	0.17	0.02	0.13	0.03
StoveTec GreenFire, wood fuel (Wet)	0.16	0.04	0.17	0.03	0.11	0.03
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.07	0.02	0.12	0.03	0.10	0.04
Upesi Portable, wood fuel (Dry)	0.17	0.01	0.14	0.03	0.09	0.01
Upesi Portable, wood fuel (Wet)	0.26	0.02	0.25	0.04	0.19	0.02
GERES, charcoal fuel(Dry)	0.17	0.05	0.09	0.09	0.03	0.03
GERES, charcoal fuel (Wet)	0.44	0.16	0.07	0.04	0.07	0.06
Gyapa, charcoal fuel (Dry)	0.41	0.24	0.31	0.15	0.07	0.06
Gyapa, charcoal fuel (Wet)	0.37	0.05	0.26	0.07	0.04	0.01
Jiko Ceramic, charcoal fuel (Dry)	0.44	0.11	0.04	0.04	0.03	0.04
Jiko Ceramic, charcoal fuel (Wet)	0.48	0.15	0.15	0.12	0.14	0.04
Jiko Metal, charcoal fuel (Dry)	0.55	0.15	0.09	0.01	0.08	0.01
Jiko Metal, charcoal fuel (Wet)	0.60	0.04	0.11	0.03	0.05	0.03
KCJ Standard, charcoal fuel (Dry)	0.49	0.07	0.21	0.20	0.09	0.05
KCJ Standard, charcoal fuel (Wet)	0.38	0.08	0.22	0.04	0.08	0.04
Kenya Uhai, charcoal fuel (Dry)	0.73	0.30	0.11	0.05	0.09	0.05
Kenya Uhai, charcoal fuel (Wet)	0.38	0.00	0.16	0.08	0.03	0.01
StoveTec Charcoal, charcoal fuel (Dry)	0.25	0.07	0.30	0.10	0.08	0.02
StoveTec Charcoal, charcoal fuel (Wet)	0.22	0.06	0.29	0.07	0.05	0.04
Belonio, rice hull fuel (Dry)	0.28	0.17	0.23	0.08	0.33	0.33
Belonio, rice hull fuel (Wet)	0.33	0.06	0.38	0.11	0.26	0.02
Mayon Turbo, rice hull fuel (Dry)	0.16	0.03	0.16	0.03	0.10	0.00
Mayon Turbo, rice hull fuel (Wet)	0.16	0.03	0.17	0.01	0.09	0.03
Oorja stove, Oorja pellet fuel (Dry)	0.04	0.02	0.03	0.01	0.17	0.09
Oorja stove, Oorja pellet fuel (Wet)	0.21	0.16	0.11	0.06	0.21	0.14
StoveTec TLUD, wood pellet fuel (Dry)	0.04	0.03	0.05	0.06	0.06	0.05
Jinqilin CKQ-80l, corn cob fuel (Dry)	0.16	0.02	0.10	0.07	0.12	0.07
Jinqilin CKQ-80l, corn cob fuel (Wet)	0.67	0.06	0.17	0.12	0.28	0.25
Protos, plant oil fuel	0.08	0.00	0.03	0.01	0.04	0.03

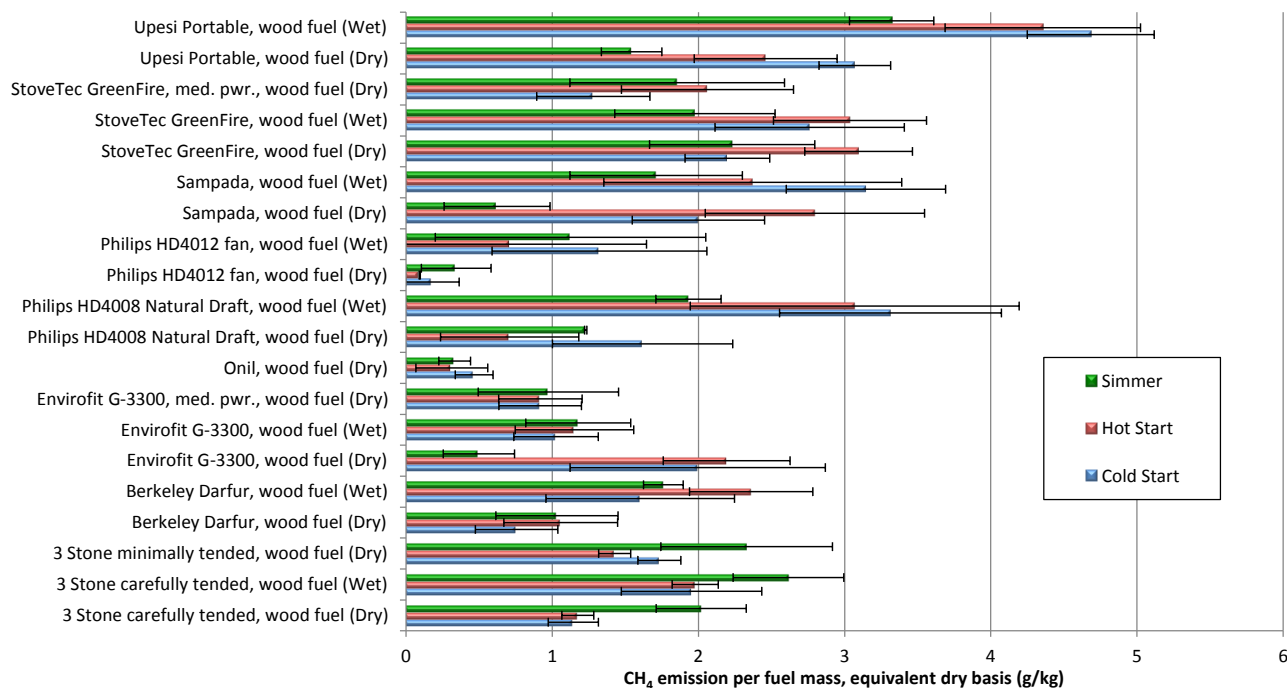
Figure S55. CH₄ Emission per Energy Delivered to Cooking Pot



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	0.4	0.1	0.4	0.0
3 Stone carefully tended, wood fuel (Wet)	0.8	0.2	0.8	0.1
3 Stone minimally tended, wood fuel (Dry)	0.7	0.1	0.6	0.1
Berkeley Darfur, wood fuel (Dry)	0.1	0.1	0.2	0.1
Berkeley Darfur, wood fuel (Wet)	0.3	0.1	0.3	0.1
Envirofit G-3300, wood fuel (Dry)	0.3	0.1	0.3	0.1
Envirofit G-3300, wood fuel (Wet)	0.2	0.0	0.2	0.0
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.1	0.0	0.1	0.0
Onil, wood fuel (Dry)	0.2	0.1	0.1	0.1
Philips HD4012 fan, wood fuel (Dry)	0.0	0.0	0.0	0.0
Philips HD4012 fan, wood fuel (Wet)	0.2	0.1	0.1	0.1
Philips HD4008 Natural Draft, wood fuel (Dry)	0.3	0.1	0.1	0.1
Philips HD4008 Natural Draft, wood fuel (Wet)	0.6	0.1	0.5	0.2
Sampada, wood fuel (Dry)	0.4	0.1	0.5	0.1
Sampada, wood fuel (Wet)	0.7	0.1	0.5	0.2

StoveTec GreenFire, wood fuel (Dry)	0.4	0.1	0.5	0.0
StoveTec GreenFire, wood fuel (Wet)	0.4	0.1	0.5	0.1
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.2	0.1	0.3	0.1
Upesi Portable, wood fuel (Dry)	0.8	0.1	0.6	0.1
Upesi Portable, wood fuel (Wet)	1.5	0.3	1.1	0.2
GERES, charcoal fuel(Dry)	1.0	0.4	0.3	0.3
GERES, charcoal fuel (Wet)	2.8	1.1	0.3	0.2
Gyapa, charcoal fuel (Dry)	1.8	1.1	1.0	0.5
Gyapa, charcoal fuel (Wet)	1.6	0.3	0.8	0.2
Jiko Ceramic, charcoal fuel (Dry)	3.2	0.8	0.1	0.1
Jiko Ceramic, charcoal fuel (Wet)	3.3	0.9	0.5	0.4
Jiko Metal, charcoal fuel (Dry)	3.8	1.5	0.3	0.0
Jiko Metal, charcoal fuel (Wet)	4.2	0.3	0.3	0.1
KCJ Standard, charcoal fuel (Dry)	2.1	0.5	0.6	0.6
KCJ Standard, charcoal fuel (Wet)	1.6	0.5	0.6	0.1
Kenya Uhai, charcoal fuel (Dry)	2.7	1.2	0.3	0.1
Kenya Uhai, charcoal fuel (Wet)	1.5	0.0	0.5	0.3
StoveTec Charcoal, charcoal fuel (Dry)	0.7	0.2	0.9	0.3
StoveTec Charcoal, charcoal fuel (Wet)	0.7	0.2	1.0	0.3
Belonio, rice hull fuel (Dry)	0.6	0.3	0.5	0.1
Belonio, rice hull fuel (Wet)	0.8	0.1	0.9	0.2
Mayon Turbo, rice hull fuel (Dry)	0.6	0.1	0.6	0.1
Mayon Turbo, rice hull fuel (Wet)	0.5	0.1	0.6	0.1
Oorja stove, Oorja pellet fuel (Dry)	0.1	0.1	0.1	0.0
Oorja stove, Oorja pellet fuel (Wet)	0.8	0.7	0.4	0.4
StoveTec TLUD, wood pellet fuel (Dry)	0.1	0.0	0.1	0.1
Jinqilin CKQ-80l, corn cob fuel (Dry)	1.7	0.4	0.6	0.3
Jinqilin CKQ-80l, corn cob fuel (Wet)	7.7	1.3	1.0	0.7
Protos, plant oil fuel	0.2	0.0	0.1	0.0

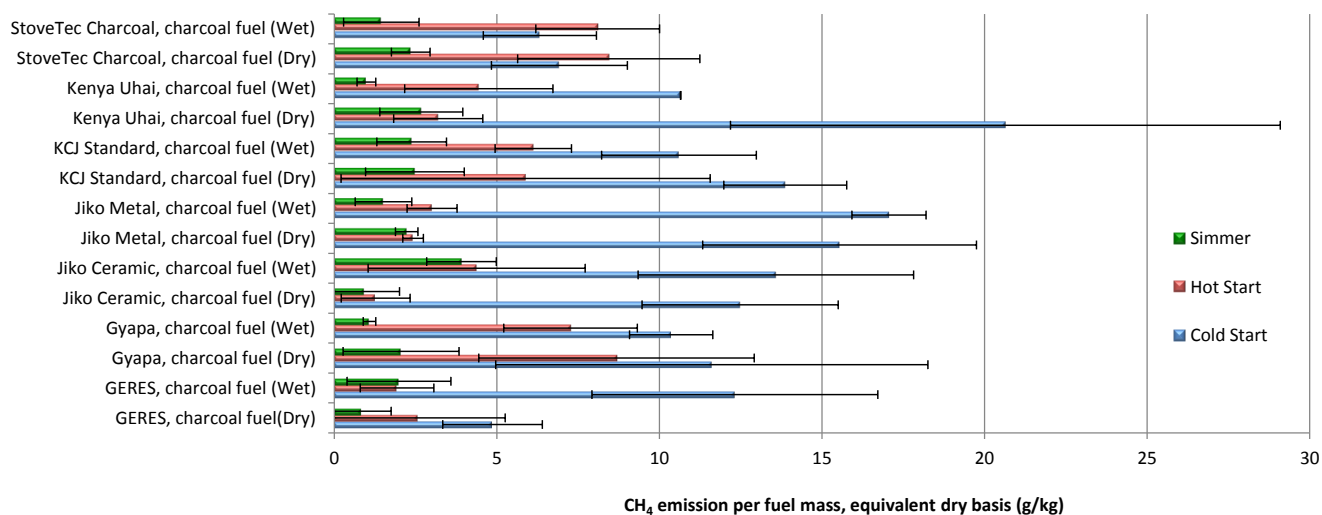
Figure S56. CH₄ Emission per Fuel Mass (Equivalent Dry Basis)
Wood Fuel



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	1.1	0.2	1.2	0.1	2.0	0.3
3 Stone carefully tended, wood fuel (Wet)	2.0	0.5	2.0	0.2	2.6	0.4
3 Stone minimally tended, wood fuel (Dry)	1.7	0.1	1.4	0.1	2.3	0.6

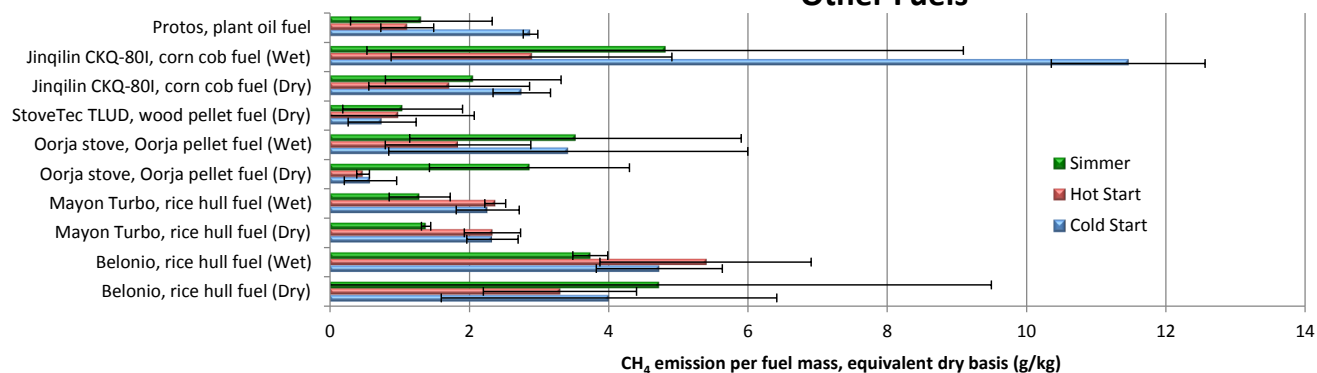
Berkeley Darfur, wood fuel (Dry)	0.8	0.3	1.1	0.4	1.0	0.4
Berkeley Darfur, wood fuel (Wet)	1.6	0.6	2.4	0.4	1.8	0.1
Envirofit G-3300, wood fuel (Dry)	2.0	0.9	2.2	0.4	0.5	0.2
Envirofit G-3300, wood fuel (Wet)	1.0	0.3	1.2	0.4	1.2	0.4
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.9	0.3	0.9	0.3	1.0	0.5
Onil, wood fuel (Dry)	0.5	0.1	0.3	0.2	0.3	0.1
Philips HD4008 Natural Draft, wood fuel (Dry)	1.6	0.6	0.7	0.5	1.2	0.0
Philips HD4008 Natural Draft, wood fuel (Wet)	3.3	0.8	3.1	1.1	1.9	0.2
Philips HD4012 fan, wood fuel (Dry)	0.2	0.2	0.1	0.0	0.3	0.2
Philips HD4012 fan, wood fuel (Wet)	1.3	0.7	0.7	0.9	1.1	0.9
Sampada, wood fuel (Dry)	2.0	0.5	2.8	0.8	0.6	0.4
Sampada, wood fuel (Wet)	3.1	0.5	2.4	1.0	1.7	0.6
StoveTec GreenFire, wood fuel (Dry)	2.2	0.3	3.1	0.4	2.2	0.6
StoveTec GreenFire, wood fuel (Wet)	2.8	0.6	3.0	0.5	2.0	0.5
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1.3	0.4	2.1	0.6	1.9	0.7
Upesi Portable, wood fuel (Dry)	3.1	0.2	2.5	0.5	1.5	0.2
Upesi Portable, wood fuel (Wet)	4.7	0.4	4.4	0.7	3.3	0.3

Figure S57. CH₄ Emission per Fuel Mass (Equivalent Dry Basis)
Charcoal Fuel



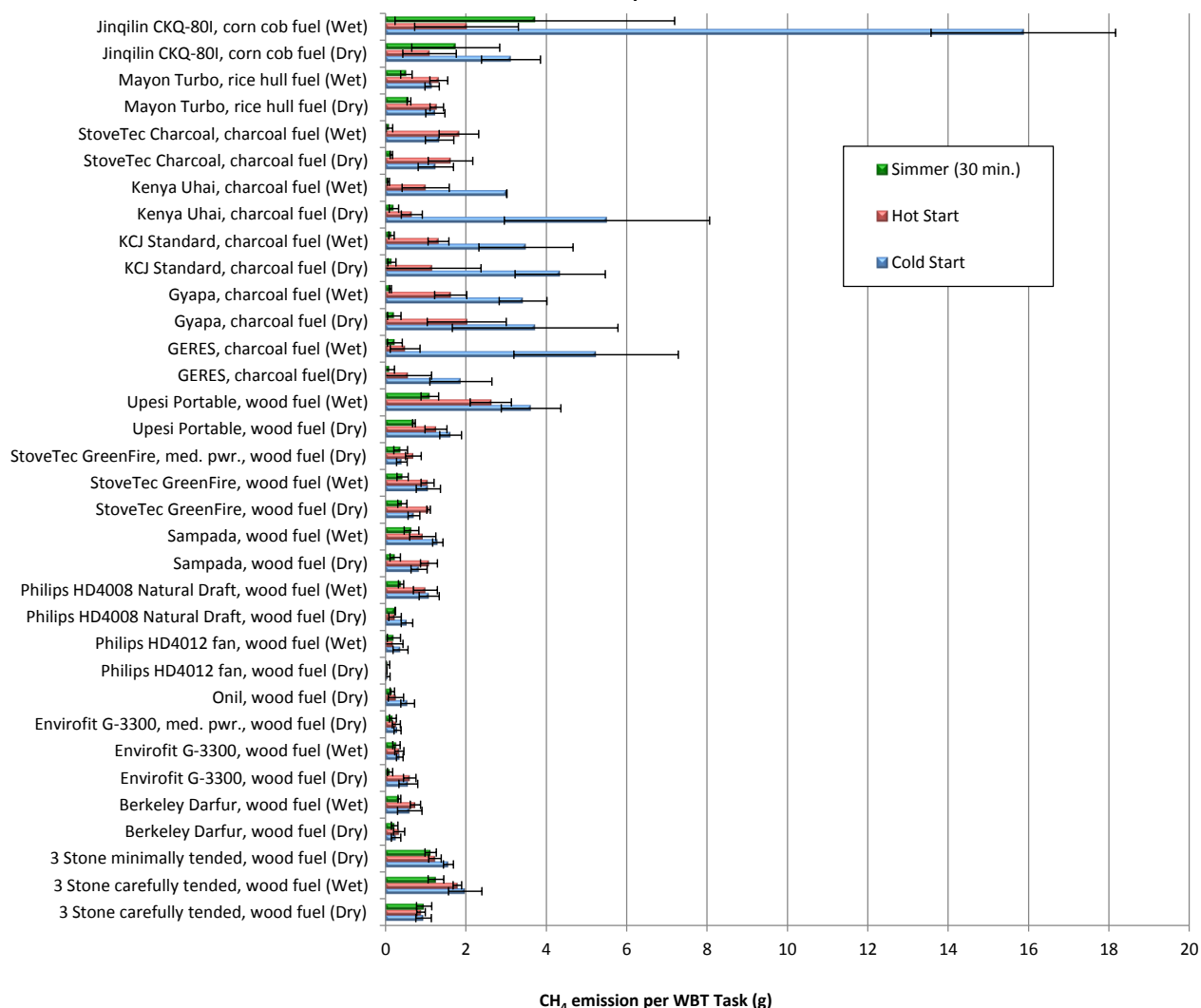
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel(Dry)	4.9	1.5	2.6	2.7	0.8	0.9
GERES, charcoal fuel (Wet)	12.3	4.4	1.9	1.1	2.0	1.6
Gyapa, charcoal fuel (Dry)	11.6	6.6	8.7	4.2	2.1	1.8
Gyapa, charcoal fuel (Wet)	10.4	1.3	7.3	2.1	1.1	0.2
Jiko Ceramic, charcoal fuel (Dry)	12.5	3.0	1.3	1.1	0.9	1.1
Jiko Ceramic, charcoal fuel (Wet)	13.6	4.2	4.4	3.3	3.9	1.1
Jiko Metal, charcoal fuel (Dry)	15.5	4.2	2.4	0.3	2.2	0.3
Jiko Metal, charcoal fuel (Wet)	17.1	1.1	3.0	0.8	1.5	0.9
KCJ Standard, charcoal fuel (Dry)	13.9	1.9	5.9	5.7	2.5	1.5
KCJ Standard, charcoal fuel (Wet)	10.6	2.4	6.1	1.2	2.4	1.1
Kenya Uhai, charcoal fuel (Dry)	20.6	8.5	3.2	1.4	2.7	1.3
Kenya Uhai, charcoal fuel (Wet)	10.7	0.0	4.4	2.3	1.0	0.3
StoveTec Charcoal, charcoal fuel (Dry)	6.9	2.1	8.4	2.8	2.3	0.6
StoveTec Charcoal, charcoal fuel (Wet)	6.3	1.7	8.1	1.9	1.4	1.2

Figure S58. CH₄ Emission per Fuel Mass (Equivalent Dry Basis)
Other Fuels



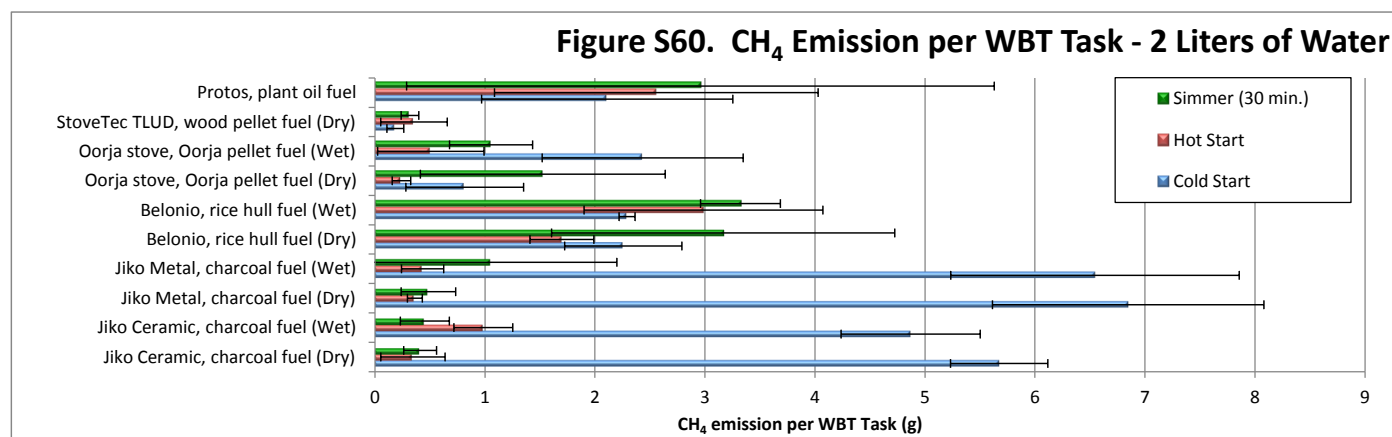
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	4.0	2.4	3.3	1.1	4.7	4.8
Belonio, rice hull fuel (Wet)	4.7	0.9	5.4	1.5	3.7	0.3
Mayon Turbo, rice hull fuel (Dry)	2.3	0.4	2.3	0.4	1.4	0.1
Mayon Turbo, rice hull fuel (Wet)	2.3	0.5	2.4	0.1	1.3	0.4
Oorja stove, Oorja pellet fuel (Dry)	0.6	0.4	0.5	0.1	2.9	1.4
Oorja stove, Oorja pellet fuel (Wet)	3.4	2.6	1.8	1.0	3.5	2.4
StoveTec TLUD, wood pellet fuel (Dry)	0.7	0.5	1.0	1.1	1.0	0.9
Jinqilin CKQ-80I, corn cob fuel (Dry)	2.8	0.4	1.7	1.2	2.1	1.3
Jinqilin CKQ-80I, corn cob fuel (Wet)	11.5	1.1	2.9	2.0	4.8	4.3
Protos, plant oil fuel	2.9	0.1	1.1	0.4	1.3	1.0

Figure S59. CH₄ Emission per WBT Task - 5 Liters of Water



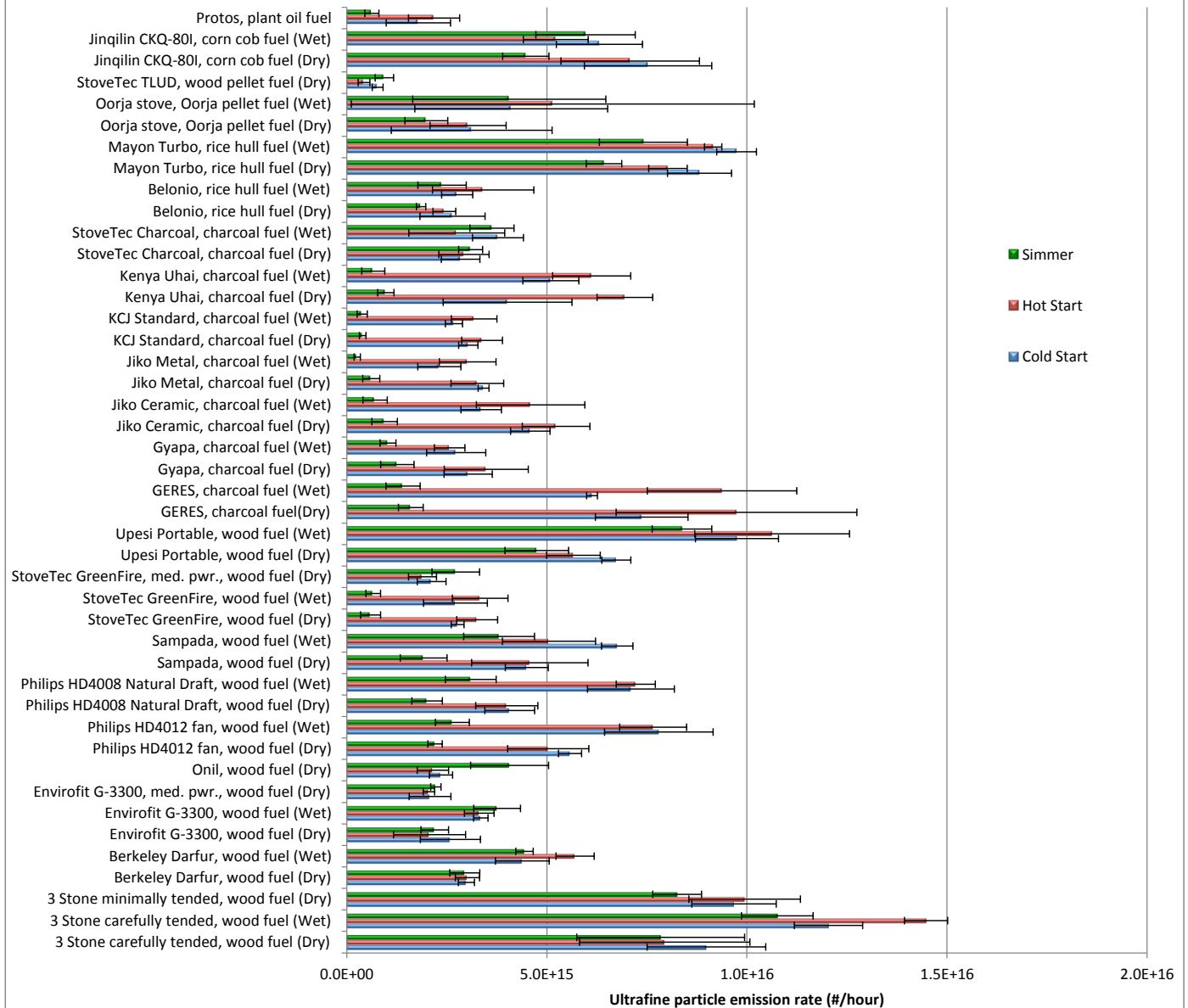
	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	0.9	0.2	0.9	0.1	1.0	0.2
3 Stone carefully tended, wood fuel (Wet)	2.0	0.4	1.8	0.1	1.3	0.2
3 Stone minimally tended, wood fuel (Dry)	1.6	0.1	1.2	0.2	1.1	0.1
Berkeley Darfur, wood fuel (Dry)	0.3	0.1	0.3	0.1	0.2	0.1
Berkeley Darfur, wood fuel (Wet)	0.6	0.3	0.7	0.1	0.3	0.0
Envirofit G-3300, wood fuel (Dry)	0.6	0.2	0.6	0.2	0.1	0.1
Envirofit G-3300, wood fuel (Wet)	0.4	0.1	0.3	0.1	0.3	0.1
Envirofit G-3300, med. pwr., wood fuel (Dry)	0.3	0.1	0.3	0.1	0.2	0.1
Onil, wood fuel (Dry)	0.6	0.2	0.3	0.2	0.2	0.1
Philips HD4012 fan, wood fuel (Dry)	0.1	0.1	0.0	0.0	0.1	0.0
Philips HD4012 fan, wood fuel (Wet)	0.4	0.2	0.2	0.2	0.2	0.2
Philips HD4008 Natural Draft, wood fuel (Dry)	0.5	0.1	0.2	0.2	0.2	0.0
Philips HD4008 Natural Draft, wood fuel (Wet)	1.1	0.2	1.0	0.3	0.4	0.1
Sampada, wood fuel (Dry)	0.8	0.2	1.1	0.2	0.2	0.1
Sampada, wood fuel (Wet)	1.3	0.1	0.9	0.3	0.6	0.2
StoveTec GreenFire, wood fuel (Dry)	0.7	0.1	1.1	0.0	0.4	0.1
StoveTec GreenFire, wood fuel (Wet)	1.1	0.3	1.0	0.2	0.4	0.1
StoveTec GreenFire, med. pwr., wood fuel (Dry)	0.4	0.1	0.7	0.2	0.4	0.2
Upesi Portable, wood fuel (Dry)	1.6	0.3	1.3	0.3	0.7	0.0
Upesi Portable, wood fuel (Wet)	3.6	0.7	2.6	0.5	1.1	0.2

GERES, charcoal fuel(Dry)	1.9	0.8	0.6	0.6	0.1	0.1
GERES, charcoal fuel (Wet)	5.2	2.0	0.5	0.4	0.2	0.2
Gyapa, charcoal fuel (Dry)	3.7	2.1	2.0	1.0	0.2	0.2
Gyapa, charcoal fuel (Wet)	3.4	0.6	1.6	0.4	0.1	0.0
KCJ Standard, charcoal fuel (Dry)	4.3	1.1	1.2	1.2	0.2	0.1
KCJ Standard, charcoal fuel (Wet)	3.5	1.2	1.3	0.3	0.1	0.1
Kenya Uhai, charcoal fuel (Dry)	5.5	2.6	0.7	0.3	0.2	0.1
Kenya Uhai, charcoal fuel (Wet)	3.0	0.0	1.0	0.6	0.1	0.0
StoveTec Charcoal, charcoal fuel (Dry)	1.3	0.4	1.6	0.6	0.1	0.0
StoveTec Charcoal, charcoal fuel (Wet)	1.3	0.4	1.8	0.5	0.1	0.1
Mayon Turbo, rice hull fuel (Dry)	1.2	0.2	1.3	0.2	0.6	0.0
Mayon Turbo, rice hull fuel (Wet)	1.2	0.2	1.3	0.2	0.5	0.1
Jinqilin CKQ-80I, corn cob fuel (Dry)	3.1	0.7	1.1	0.7	1.7	1.1
Jinqilin CKQ-80I, corn cob fuel (Wet)	15.9	2.3	2.0	1.3	3.7	3.5



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Jiko Ceramic, charcoal fuel (Dry)	5.7	0.4	0.3	0.3	0.4	0.1
Jiko Ceramic, charcoal fuel (Wet)	4.9	0.6	1.0	0.3	0.5	0.2
Jiko Metal, charcoal fuel (Dry)	6.8	1.2	0.4	0.1	0.5	0.2
Jiko Metal, charcoal fuel (Wet)	6.5	1.3	0.4	0.2	1.1	1.1
Belonio, rice hull fuel (Dry)	2.3	0.5	1.7	0.3	3.2	1.6
Belonio, rice hull fuel (Wet)	2.3	0.1	3.0	1.1	3.3	0.4
Oorja stove, Oorja pellet fuel (Dry)	0.8	0.5	0.2	0.1	1.5	1.1
Oorja stove, Oorja pellet fuel (Wet)	2.4	0.9	0.5	0.5	1.1	0.4
StoveTec TLUD, wood pellet fuel (Dry)	0.2	0.1	0.4	0.3	0.3	0.1
Protos, plant oil fuel	2.1	1.1	2.6	1.5	3.0	2.7

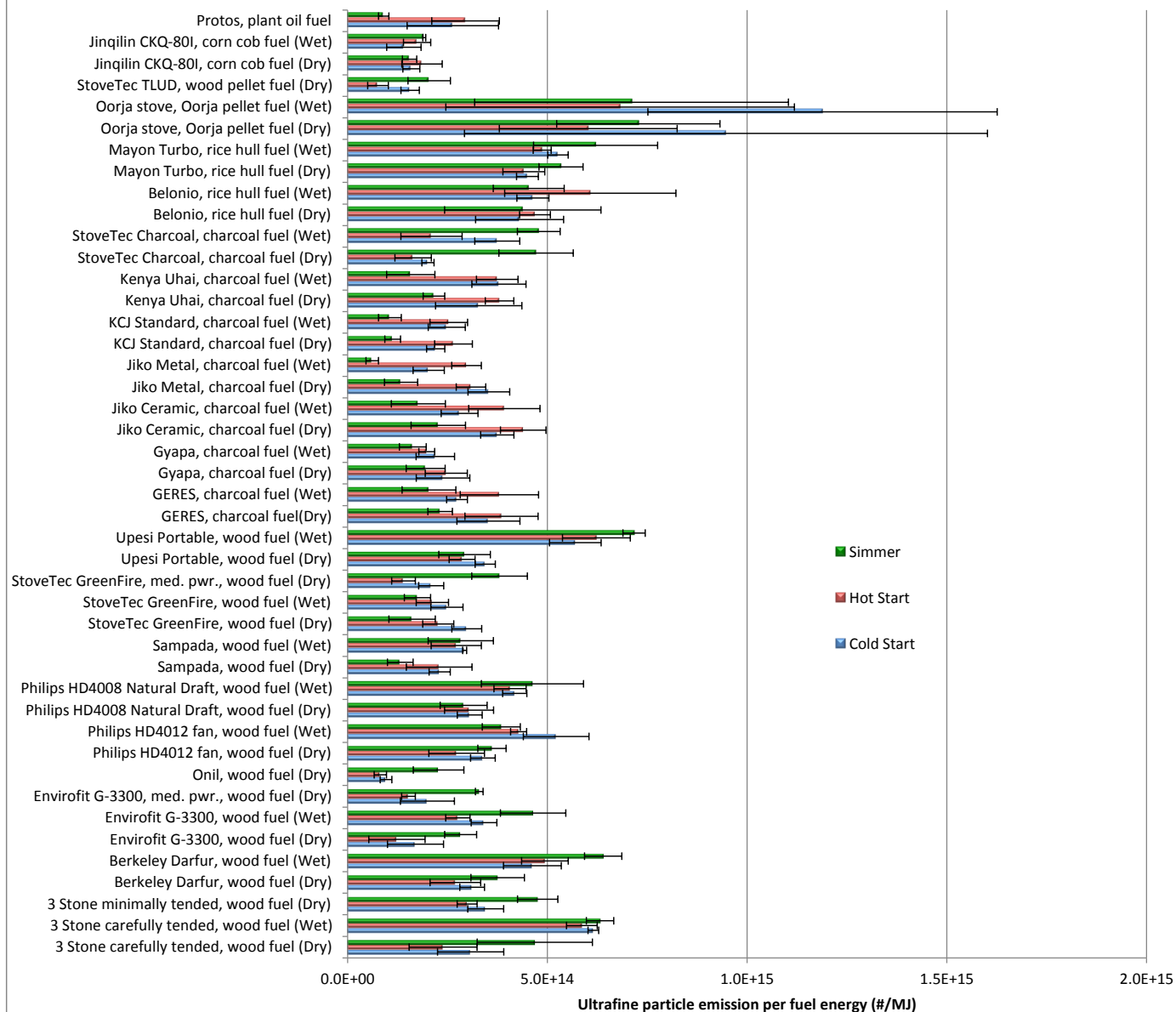
Figure S61. Ultrafine Particle Emission Rate (per Time)



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	8.99E+15	1.48E+15	7.95E+15	2.13E+15	7.85E+15	2.10E+15
3 Stone carefully tended, wood fuel (Wet)	1.20E+16	8.55E+14	1.45E+16	5.39E+14	1.08E+16	8.95E+14
3 Stone minimally tended, wood fuel (Dry)	9.68E+15	1.06E+15	9.95E+15	1.39E+15	8.26E+15	6.10E+14
Berkeley Darfur, wood fuel (Dry)	2.99E+15	2.01E+14	3.02E+15	3.03E+14	2.95E+15	3.75E+14
Berkeley Darfur, wood fuel (Wet)	4.39E+15	6.71E+14	5.71E+15	4.77E+14	4.44E+15	2.18E+14
Envirofit G-3300, wood fuel (Dry)	2.59E+15	7.50E+14	2.07E+15	9.01E+14	2.20E+15	3.46E+14
Envirofit G-3300, wood fuel (Wet)	3.35E+15	1.80E+14	3.31E+15	3.70E+14	3.76E+15	5.84E+14
Envirofit G-3300, med. pwr., wood fuel (Dry)	2.08E+15	5.22E+14	2.05E+15	1.41E+14	2.23E+15	1.29E+14
Onil, wood fuel (Dry)	2.35E+15	2.90E+14	2.15E+15	3.92E+14	4.07E+15	9.74E+14
Philips HD4012 fan, wood fuel (Dry)	5.58E+15	2.89E+14	5.04E+15	1.02E+15	2.21E+15	1.79E+14
Philips HD4012 fan, wood fuel (Wet)	7.80E+15	1.36E+15	7.66E+15	8.37E+14	2.64E+15	4.23E+14
Philips HD4008 Natural Draft, wood fuel (Dry)	4.07E+15	6.22E+14	4.00E+15	7.78E+14	2.01E+15	3.81E+14
Philips HD4008 Natural Draft, wood fuel (Wet)	7.10E+15	1.09E+15	7.22E+15	4.89E+14	3.10E+15	6.34E+14
Sampada, wood fuel (Dry)	4.50E+15	5.36E+14	4.58E+15	1.46E+15	1.92E+15	5.86E+14

Sampada, wood fuel (Wet)	6.76E+15	3.92E+14	5.05E+15	1.16E+15	3.81E+15	8.85E+14
StoveTec GreenFire, wood fuel (Dry)	2.77E+15	1.61E+14	3.26E+15	5.10E+14	5.95E+14	2.50E+14
StoveTec GreenFire, wood fuel (Wet)	2.72E+15	7.98E+14	3.33E+15	6.95E+14	6.61E+14	1.83E+14
StoveTec GreenFire, med. pwr., wood fuel (Dry)	2.12E+15	3.60E+14	1.89E+15	3.50E+14	2.72E+15	5.95E+14
Upesi Portable, wood fuel (Dry)	6.74E+15	3.62E+14	5.67E+15	6.71E+14	4.75E+15	7.95E+14
Upesi Portable, wood fuel (Wet)	9.75E+15	1.04E+15	1.06E+16	1.93E+15	8.38E+15	7.45E+14
GERES, charcoal fuel(Dry)	7.37E+15	1.16E+15	9.74E+15	3.01E+15	1.60E+15	3.09E+14
GERES, charcoal fuel (Wet)	6.13E+15	1.35E+14	9.38E+15	1.87E+15	1.41E+15	4.26E+14
Gyapa, charcoal fuel (Dry)	3.03E+15	6.02E+14	3.49E+15	1.05E+15	1.26E+15	4.18E+14
Gyapa, charcoal fuel (Wet)	2.73E+15	7.39E+14	2.57E+15	3.82E+14	1.03E+15	1.98E+14
Jiko Ceramic, charcoal fuel (Dry)	4.59E+15	4.93E+14	5.23E+15	8.45E+14	9.45E+14	3.20E+14
Jiko Ceramic, charcoal fuel (Wet)	3.36E+15	5.07E+14	4.59E+15	1.36E+15	7.07E+14	3.04E+14
Jiko Metal, charcoal fuel (Dry)	3.42E+15	1.36E+14	3.26E+15	6.58E+14	6.12E+14	2.14E+14
Jiko Metal, charcoal fuel (Wet)	2.31E+15	5.39E+14	3.02E+15	7.09E+14	2.61E+14	7.83E+13
KCJ Standard, charcoal fuel (Dry)	3.04E+15	2.41E+14	3.38E+15	5.09E+14	3.97E+14	8.24E+13
KCJ Standard, charcoal fuel (Wet)	2.68E+15	2.14E+14	3.18E+15	5.70E+14	3.85E+14	1.27E+14
Kenya Uhai, charcoal fuel (Dry)	4.02E+15	1.61E+15	6.95E+15	6.95E+14	9.75E+14	2.05E+14
Kenya Uhai, charcoal fuel (Wet)	5.10E+15	6.99E+14	6.12E+15	9.76E+14	6.62E+14	2.88E+14
StoveTec Charcoal, charcoal fuel (Dry)	2.84E+15	4.83E+14	2.93E+15	6.29E+14	3.10E+15	3.00E+14
StoveTec Charcoal, charcoal fuel (Wet)	3.78E+15	6.37E+14	2.75E+15	1.20E+15	3.63E+15	5.51E+14
Belonio, rice hull fuel (Dry)	2.64E+15	8.14E+14	2.44E+15	2.84E+14	1.86E+15	1.17E+14
Belonio, rice hull fuel (Wet)	2.76E+15	3.89E+14	3.41E+15	1.27E+15	2.38E+15	6.05E+14
Mayon Turbo, rice hull fuel (Dry)	8.82E+15	8.00E+14	8.03E+15	4.82E+14	6.43E+15	4.44E+14
Mayon Turbo, rice hull fuel (Wet)	9.74E+15	4.96E+14	9.16E+15	2.17E+14	7.41E+15	1.10E+15
Oorja stove, Oorja pellet fuel (Dry)	3.12E+15	2.01E+15	3.03E+15	9.51E+14	1.99E+15	5.36E+14
Oorja stove, Oorja pellet fuel (Wet)	4.11E+15	2.41E+15	5.15E+15	5.04E+15	4.06E+15	2.41E+15
StoveTec TLUD, wood pellet fuel (Dry)	7.71E+14	1.36E+14	4.30E+14	1.47E+14	9.39E+14	2.31E+14
Jinqilin CKQ-80I, corn cob fuel (Dry)	7.53E+15	1.59E+15	7.08E+15	1.73E+15	4.47E+15	5.79E+14
Jinqilin CKQ-80I, corn cob fuel (Wet)	6.31E+15	1.08E+15	5.22E+15	8.11E+14	5.97E+15	1.24E+15
Protos, plant oil fuel	1.79E+15	8.04E+14	2.18E+15	6.39E+14	6.27E+14	1.76E+14

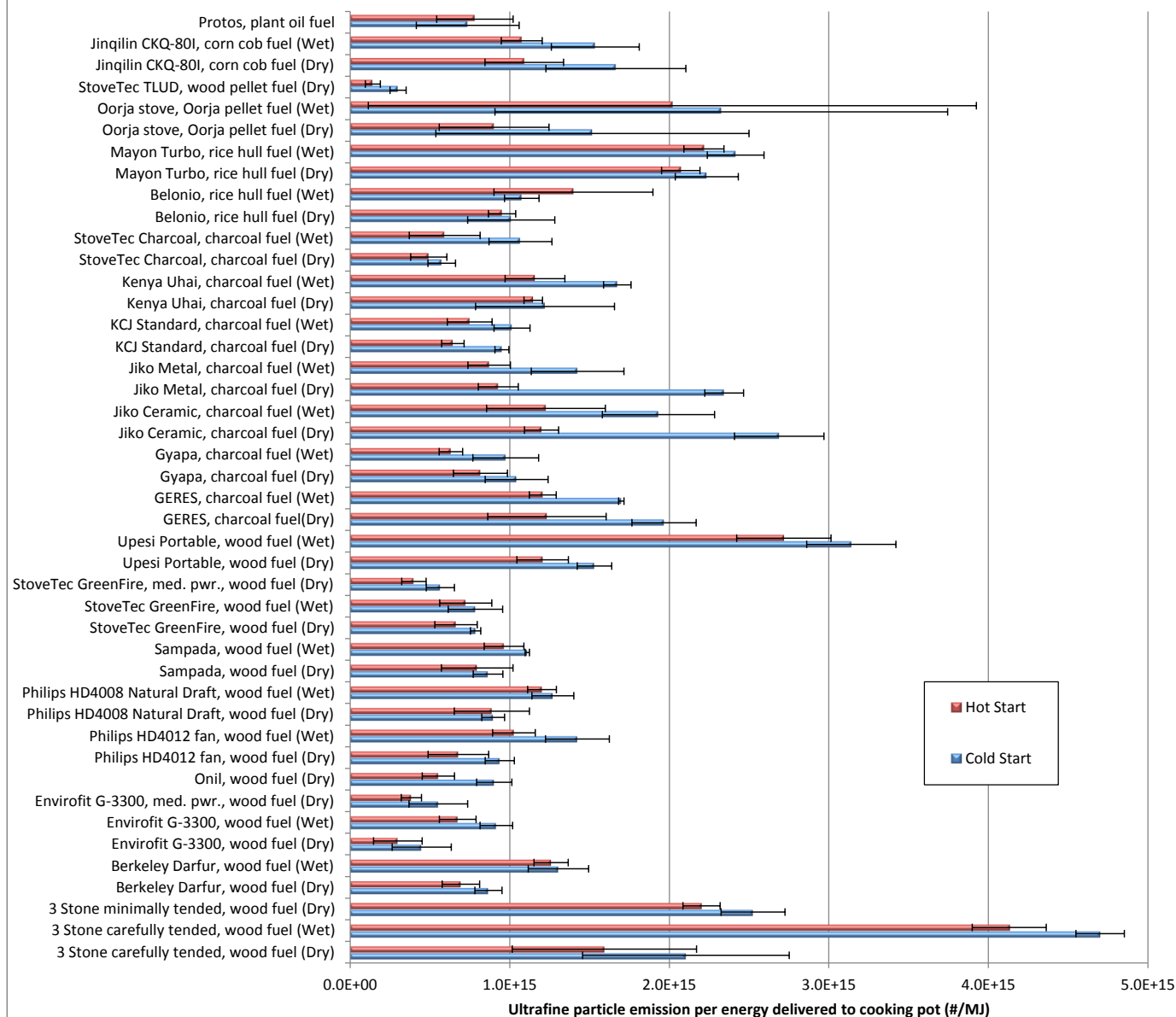
Figure S62. Ultrafine Particle Emission per Fuel Energy



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	3.08E+14	8.29E+13	2.39E+14	8.50E+13	4.69E+14	1.44E+14
3 Stone carefully tended, wood fuel (Wet)	6.15E+14	1.33E+13	5.86E+14	3.85E+13	6.32E+14	3.43E+13
3 Stone minimally tended, wood fuel (Dry)	3.46E+14	4.50E+13	2.99E+14	2.49E+13	4.76E+14	5.04E+13
Berkeley Darfur, wood fuel (Dry)	3.12E+14	3.10E+13	2.70E+14	6.34E+13	3.76E+14	6.69E+13
Berkeley Darfur, wood fuel (Wet)	4.63E+14	7.23E+13	4.94E+14	5.84E+13	6.40E+14	4.67E+13
Envirofit G-3300, wood fuel (Dry)	1.70E+14	7.02E+13	1.24E+14	7.05E+13	2.83E+14	4.00E+13
Envirofit G-3300, wood fuel (Wet)	3.42E+14	3.22E+13	2.76E+14	3.04E+13	4.64E+14	8.18E+13
Envirofit G-3300, med. pwr., wood fuel (Dry)	2.00E+14	6.76E+13	1.52E+14	1.72E+13	3.30E+14	9.59E+12
Onil, wood fuel (Dry)	9.62E+13	1.47E+13	8.19E+13	1.55E+13	2.28E+14	6.34E+13
Philips HD4012 fan, wood fuel (Dry)	3.39E+14	3.09E+13	2.73E+14	6.96E+13	3.61E+14	3.53E+13
Philips HD4012 fan, wood fuel (Wet)	5.22E+14	8.22E+13	4.28E+14	2.01E+13	3.85E+14	4.77E+13
Philips HD4008 Natural Draft, wood fuel (Dry)	3.06E+14	3.12E+13	3.04E+14	6.14E+13	2.91E+14	5.88E+13
Philips HD4008 Natural Draft, wood fuel (Wet)	4.18E+14	3.03E+13	4.07E+14	4.03E+13	4.63E+14	1.28E+14
Sampada, wood fuel (Dry)	2.31E+14	2.65E+13	2.29E+14	8.22E+13	1.32E+14	3.21E+13
Sampada, wood fuel (Wet)	2.93E+14	5.03E+12	2.72E+14	6.28E+13	2.83E+14	8.16E+13

StoveTec GreenFire, wood fuel (Dry)	2.98E+14	3.74E+13	2.27E+14	3.89E+13	1.62E+14	5.81E+13
StoveTec GreenFire, wood fuel (Wet)	2.49E+14	4.03E+13	2.12E+14	4.04E+13	1.75E+14	3.28E+13
StoveTec GreenFire, med. pwr., wood fuel (Dry)	2.09E+14	3.14E+13	1.40E+14	2.97E+13	3.80E+14	6.96E+13
Upesi Portable, wood fuel (Dry)	3.45E+14	2.53E+13	2.87E+14	3.25E+13	2.93E+14	6.46E+13
Upesi Portable, wood fuel (Wet)	5.70E+14	6.47E+13	6.23E+14	8.49E+13	7.17E+14	2.79E+13
GERES, charcoal fuel (Dry)	3.53E+14	7.89E+13	3.85E+14	9.16E+13	2.32E+14	3.07E+13
GERES, charcoal fuel (Wet)	2.74E+14	2.60E+13	3.80E+14	9.81E+13	2.04E+14	6.73E+13
Gyapa, charcoal fuel (Dry)	2.39E+14	6.70E+13	2.47E+14	5.27E+13	1.95E+14	4.88E+13
Gyapa, charcoal fuel (Wet)	2.20E+14	4.82E+13	1.98E+14	1.98E+13	1.63E+14	3.36E+13
Jiko Ceramic, charcoal fuel (Dry)	3.75E+14	4.17E+13	4.40E+14	5.69E+13	2.27E+14	6.81E+13
Jiko Ceramic, charcoal fuel (Wet)	2.80E+14	4.61E+13	3.92E+14	8.92E+13	1.77E+14	6.77E+13
Jiko Metal, charcoal fuel (Dry)	3.54E+14	5.22E+13	3.09E+14	3.70E+13	1.34E+14	4.16E+13
Jiko Metal, charcoal fuel (Wet)	2.03E+14	3.91E+13	2.98E+14	3.70E+13	6.16E+13	1.56E+13
KCJ Standard, charcoal fuel (Dry)	2.21E+14	2.28E+13	2.65E+14	4.72E+13	1.13E+14	1.96E+13
KCJ Standard, charcoal fuel (Wet)	2.48E+14	4.64E+13	2.53E+14	4.72E+13	1.06E+14	2.86E+13
Kenya Uhai, charcoal fuel (Dry)	3.28E+14	1.08E+14	3.80E+14	3.57E+13	2.16E+14	2.70E+13
Kenya Uhai, charcoal fuel (Wet)	3.79E+14	6.77E+13	3.75E+14	5.20E+13	1.58E+14	6.04E+13
StoveTec Charcoal, charcoal fuel (Dry)	2.01E+14	1.52E+13	1.64E+14	4.55E+13	4.72E+14	9.31E+13
StoveTec Charcoal, charcoal fuel (Wet)	3.75E+14	5.63E+13	2.10E+14	7.66E+13	4.79E+14	5.35E+13
Belonio, rice hull fuel (Dry)	4.31E+14	1.10E+14	4.69E+14	3.86E+13	4.39E+14	1.96E+14
Belonio, rice hull fuel (Wet)	4.64E+14	4.00E+13	6.08E+14	2.14E+14	4.53E+14	8.88E+13
Mayon Turbo, rice hull fuel (Dry)	4.50E+14	2.73E+13	4.41E+14	5.24E+13	5.34E+14	5.51E+13
Mayon Turbo, rice hull fuel (Wet)	5.27E+14	2.55E+13	4.87E+14	2.25E+13	6.21E+14	1.55E+14
Oorja stove, Oorja pellet fuel (Dry)	9.47E+14	6.55E+14	6.02E+14	2.23E+14	7.28E+14	2.04E+14
Oorja stove, Oorja pellet fuel (Wet)	1.19E+15	4.37E+14	6.82E+14	4.36E+14	7.11E+14	3.93E+14
StoveTec TLUD, wood pellet fuel (Dry)	1.57E+14	2.30E+13	7.61E+13	2.59E+13	2.04E+14	5.31E+13
Jinqilin CKQ-80I, corn cob fuel (Dry)	1.60E+14	2.12E+13	1.86E+14	5.06E+13	1.55E+14	1.79E+13
Jinqilin CKQ-80I, corn cob fuel (Wet)	1.41E+14	4.30E+13	1.74E+14	3.41E+13	1.92E+14	3.73E+12
Protos, plant oil fuel	2.63E+14	1.14E+14	2.95E+14	8.46E+13	9.04E+13	1.30E+13

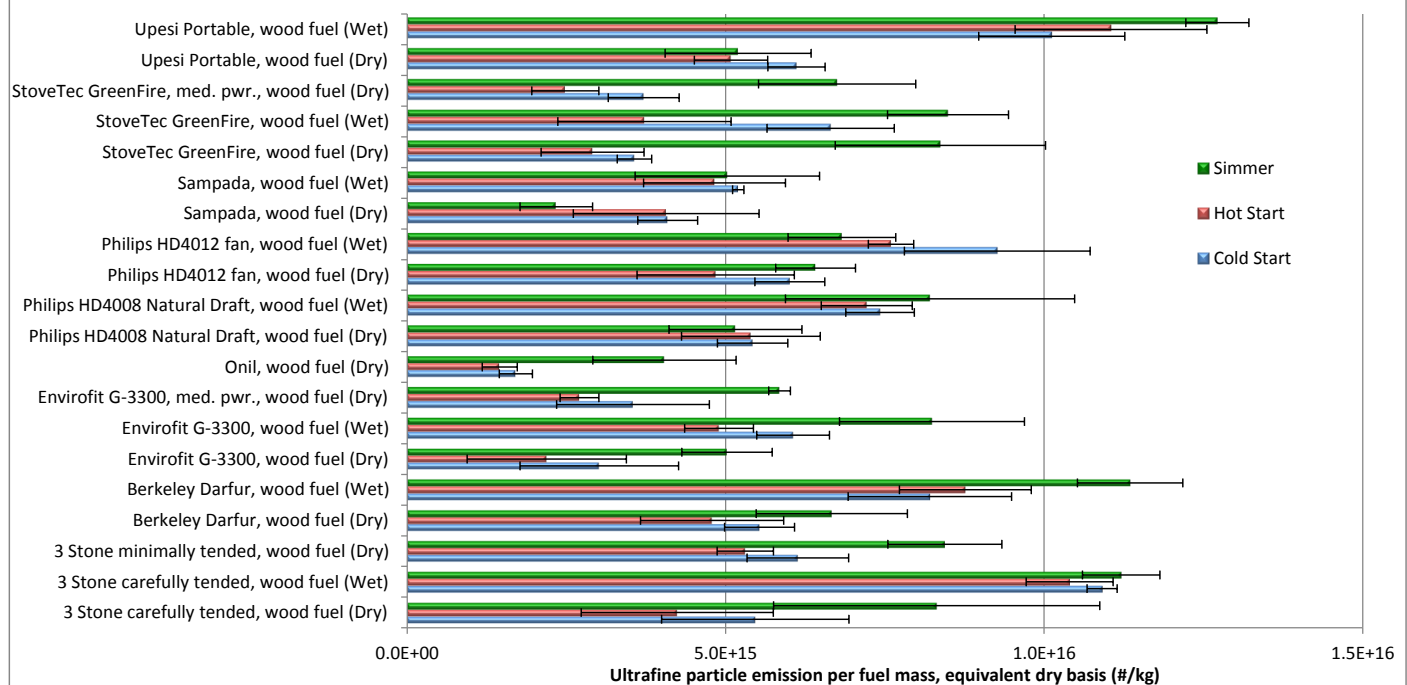
Figure S63. Ultrafine Particle Emission per Energy Delivered to Cooking Pot



	Cold Start		Hot Start	
	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	2.10E+15	6.48E+14	1.59E+15	5.78E+14
3 Stone carefully tended, wood fuel (Wet)	4.70E+15	1.52E+14	4.13E+15	2.32E+14
3 Stone minimally tended, wood fuel (Dry)	2.53E+15	2.00E+14	2.20E+15	1.17E+14
Berkeley Darfur, wood fuel (Dry)	8.66E+14	8.52E+13	6.94E+14	1.17E+14
Berkeley Darfur, wood fuel (Wet)	1.31E+15	1.89E+14	1.26E+15	1.07E+14
Envirofit G-3300, wood fuel (Dry)	4.48E+14	1.85E+14	2.98E+14	1.52E+14
Envirofit G-3300, wood fuel (Wet)	9.16E+14	1.02E+14	6.74E+14	1.15E+14
Envirofit G-3300, med. pwr., wood fuel (Dry)	5.52E+14	1.84E+14	3.83E+14	6.33E+13
Onil, wood fuel (Dry)	9.02E+14	1.11E+14	5.52E+14	1.01E+14
Philips HD4012 fan, wood fuel (Dry)	9.37E+14	9.14E+13	6.78E+14	1.90E+14
Philips HD4012 fan, wood fuel (Wet)	1.42E+15	2.00E+14	1.03E+15	1.34E+14
Philips HD4008 Natural Draft, wood fuel (Dry)	8.96E+14	7.16E+13	8.88E+14	2.36E+14
Philips HD4008 Natural Draft, wood fuel (Wet)	1.27E+15	1.31E+14	1.20E+15	9.01E+13
Sampada, wood fuel (Dry)	8.64E+14	9.31E+13	7.96E+14	2.24E+14
Sampada, wood fuel (Wet)	1.11E+15	1.33E+13	9.64E+14	1.24E+14

StoveTec GreenFire, wood fuel (Dry)	7.86E+14	3.24E+13	6.63E+14	1.33E+14
StoveTec GreenFire, wood fuel (Wet)	7.85E+14	1.71E+14	7.24E+14	1.63E+14
StoveTec GreenFire, med. pwr., wood fuel (Dry)	5.64E+14	8.82E+13	3.99E+14	7.65E+13
Upesi Portable, wood fuel (Dry)	1.53E+15	1.08E+14	1.21E+15	1.61E+14
Upesi Portable, wood fuel (Wet)	3.14E+15	2.80E+14	2.72E+15	2.96E+14
GERES, charcoal fuel(Dry)	1.97E+15	2.01E+14	1.23E+15	3.71E+14
GERES, charcoal fuel (Wet)	1.70E+15	1.70E+13	1.21E+15	8.42E+13
Gyapa, charcoal fuel (Dry)	1.04E+15	1.97E+14	8.16E+14	1.69E+14
Gyapa, charcoal fuel (Wet)	9.75E+14	2.06E+14	6.31E+14	7.37E+13
Jiko Ceramic, charcoal fuel (Dry)	2.69E+15	2.81E+14	1.20E+15	1.07E+14
Jiko Ceramic, charcoal fuel (Wet)	1.93E+15	3.52E+14	1.23E+15	3.72E+14
Jiko Metal, charcoal fuel (Dry)	2.34E+15	1.22E+14	9.28E+14	1.26E+14
Jiko Metal, charcoal fuel (Wet)	1.43E+15	2.91E+14	8.71E+14	1.33E+14
KCJ Standard, charcoal fuel (Dry)	9.51E+14	4.40E+13	6.43E+14	7.03E+13
KCJ Standard, charcoal fuel (Wet)	1.01E+15	1.13E+14	7.49E+14	1.40E+14
Kenya Uhai, charcoal fuel (Dry)	1.22E+15	4.35E+14	1.15E+15	5.80E+13
Kenya Uhai, charcoal fuel (Wet)	1.67E+15	8.62E+13	1.16E+15	1.87E+14
StoveTec Charcoal, charcoal fuel (Dry)	5.73E+14	8.64E+13	4.92E+14	1.13E+14
StoveTec Charcoal, charcoal fuel (Wet)	1.07E+15	1.97E+14	5.92E+14	2.22E+14
Belonio, rice hull fuel (Dry)	1.01E+15	2.73E+14	9.52E+14	8.55E+13
Belonio, rice hull fuel (Wet)	1.08E+15	1.08E+14	1.40E+15	4.98E+14
Mayon Turbo, rice hull fuel (Dry)	2.24E+15	1.98E+14	2.07E+15	1.20E+14
Mayon Turbo, rice hull fuel (Wet)	2.42E+15	1.78E+14	2.22E+15	1.26E+14
Oorja stove, Oorja pellet fuel (Dry)	1.52E+15	9.82E+14	9.02E+14	3.44E+14
Oorja stove, Oorja pellet fuel (Wet)	2.33E+15	1.42E+15	2.02E+15	1.91E+15
StoveTec TLUD, wood pellet fuel (Dry)	3.00E+14	5.05E+13	1.41E+14	4.71E+13
Jinqilin CKQ-80I, corn cob fuel (Dry)	1.67E+15	4.39E+14	1.09E+15	2.46E+14
Jinqilin CKQ-80I, corn cob fuel (Wet)	1.54E+15	2.76E+14	1.08E+15	1.28E+14
Protos, plant oil fuel	7.36E+14	3.22E+14	7.81E+14	2.40E+14

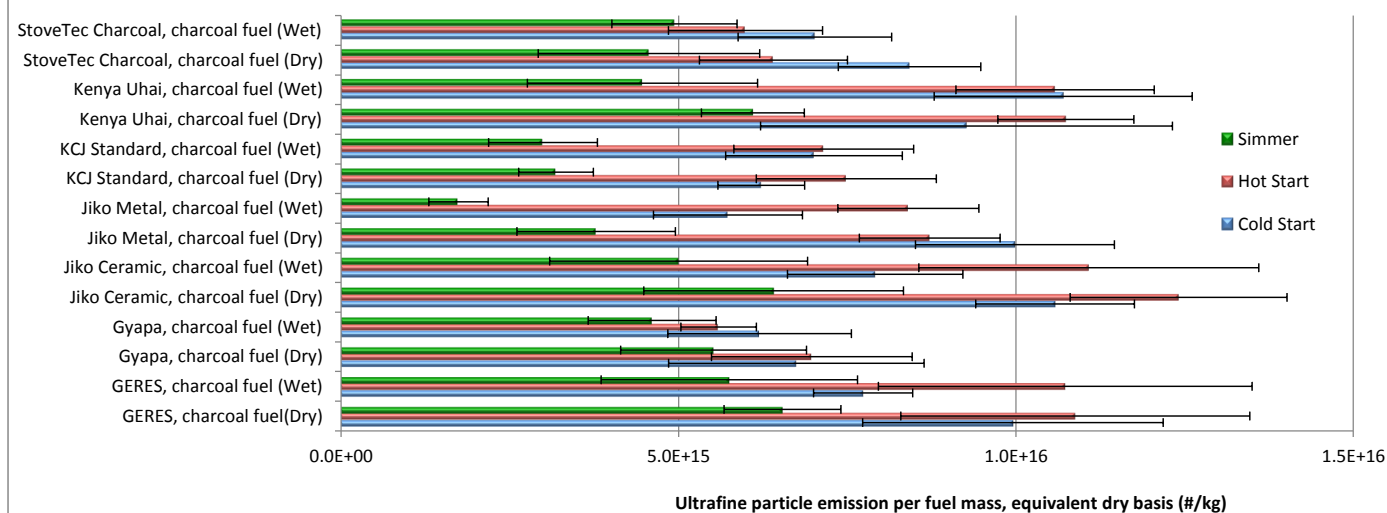
**Figure S64. Ultrafine Particle Emission per Fuel Mass (Equivalent Dry Basis)
- Wood Fuel**



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	5.47E+15	1.47E+15	4.24E+15	1.51E+15	8.31E+15	2.56E+15
3 Stone carefully tended, wood fuel (Wet)	1.09E+16	2.36E+14	1.04E+16	6.82E+14	1.12E+16	6.08E+14
3 Stone minimally tended, wood fuel (Dry)	6.13E+15	7.98E+14	5.31E+15	4.42E+14	8.44E+15	8.95E+14

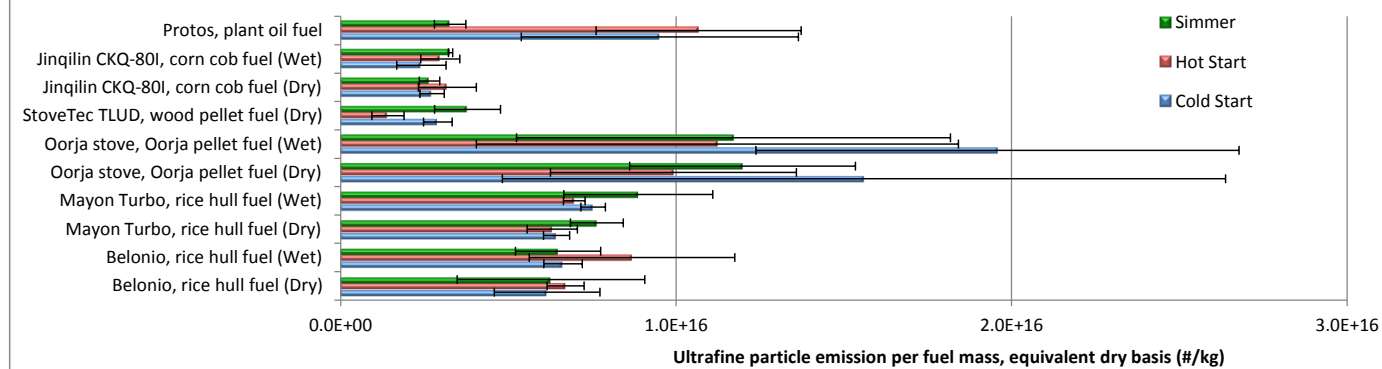
Berkeley Darfur, wood fuel (Dry)	5.53E+15	5.49E+14	4.79E+15	1.12E+15	6.67E+15	1.19E+15
Berkeley Darfur, wood fuel (Wet)	8.21E+15	1.28E+15	8.76E+15	1.04E+15	1.14E+16	8.28E+14
Envirofit G-3300, wood fuel (Dry)	3.02E+15	1.25E+15	2.19E+15	1.25E+15	5.02E+15	7.09E+14
Envirofit G-3300, wood fuel (Wet)	6.06E+15	5.71E+14	4.90E+15	5.40E+14	8.24E+15	1.45E+15
Envirofit G-3300, med. pwr., wood fuel (Dry)	3.55E+15	1.20E+15	2.71E+15	3.05E+14	5.85E+15	1.70E+14
Onil, wood fuel (Dry)	1.71E+15	2.60E+14	1.45E+15	2.75E+14	4.04E+15	1.12E+15
Philips HD4008 Natural Draft, wood fuel (Dry)	5.42E+15	5.53E+14	5.40E+15	1.09E+15	5.15E+15	1.04E+15
Philips HD4008 Natural Draft, wood fuel (Wet)	7.42E+15	5.38E+14	7.22E+15	7.14E+14	8.21E+15	2.27E+15
Philips HD4012 fan, wood fuel (Dry)	6.01E+15	5.48E+14	4.84E+15	1.24E+15	6.41E+15	6.26E+14
Philips HD4012 fan, wood fuel (Wet)	9.26E+15	1.46E+15	7.60E+15	3.56E+14	6.83E+15	8.46E+14
Sampada, wood fuel (Dry)	4.09E+15	4.70E+14	4.07E+15	1.46E+15	2.34E+15	5.70E+14
Sampada, wood fuel (Wet)	5.20E+15	8.92E+13	4.83E+15	1.11E+15	5.03E+15	1.45E+15
StoveTec GreenFire, wood fuel (Dry)	3.57E+15	2.70E+14	2.91E+15	8.08E+14	8.37E+15	1.65E+15
StoveTec GreenFire, wood fuel (Wet)	6.65E+15	9.99E+14	3.73E+15	1.36E+15	8.49E+15	9.50E+14
StoveTec GreenFire, med. pwr., wood fuel (Dry)	3.71E+15	5.56E+14	2.48E+15	5.26E+14	6.75E+15	1.23E+15
Upesi Portable, wood fuel (Dry)	6.11E+15	4.49E+14	5.08E+15	5.76E+14	5.20E+15	1.15E+15
Upesi Portable, wood fuel (Wet)	1.01E+16	1.15E+15	1.11E+16	1.51E+15	1.27E+16	4.95E+14

**Figure S65. Ultrafine Particle Emission per Fuel Mass (Equivalent Dry Basis)
- Charcoal Fuel**



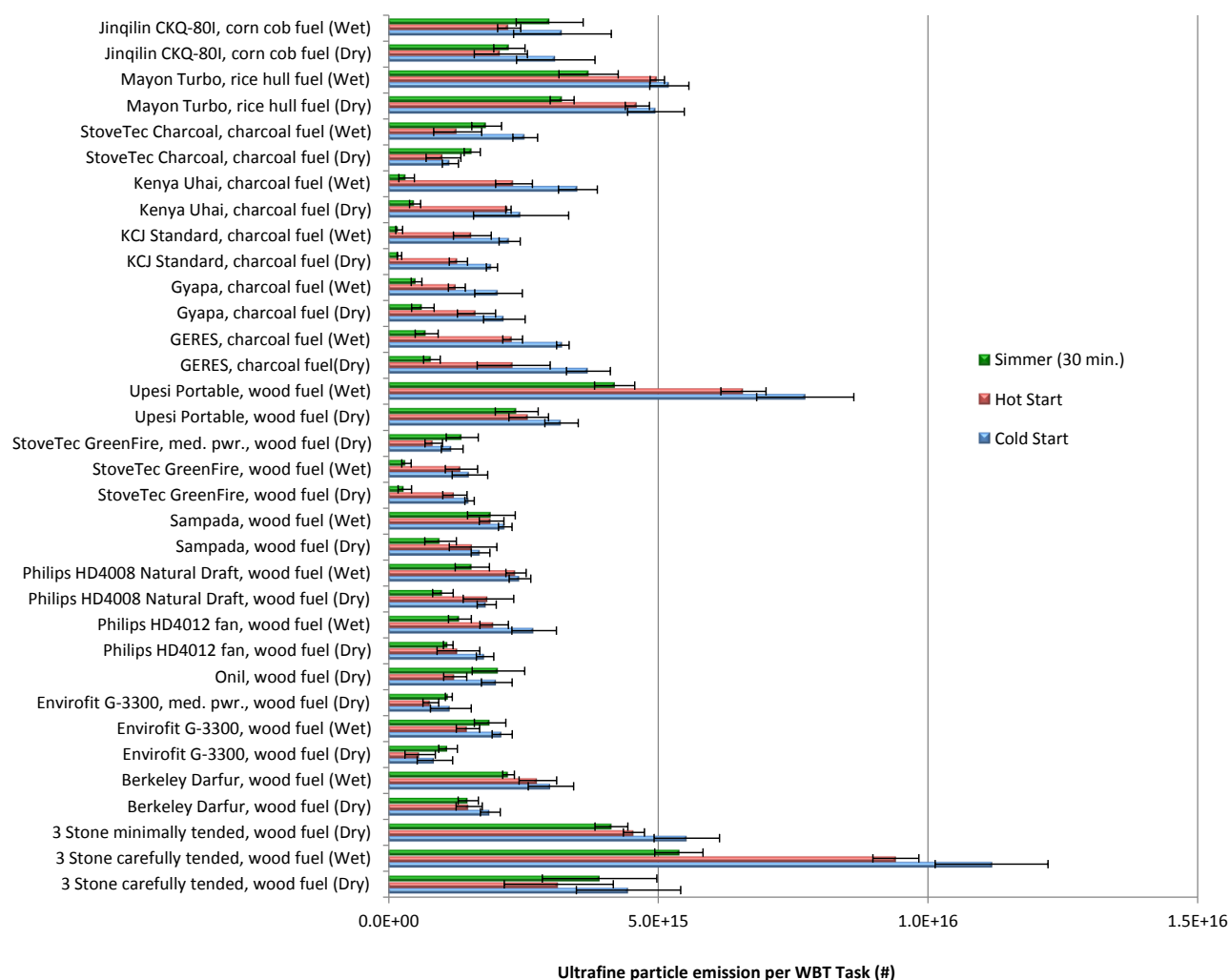
	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
GERES, charcoal fuel(Dry)	9.96E+15	2.23E+15	1.09E+16	2.59E+15	6.54E+15	8.66E+14
GERES, charcoal fuel (Wet)	7.74E+15	7.35E+14	1.07E+16	2.77E+15	5.75E+15	1.90E+15
Gyapa, charcoal fuel (Dry)	6.75E+15	1.89E+15	6.98E+15	1.49E+15	5.52E+15	1.38E+15
Gyapa, charcoal fuel (Wet)	6.20E+15	1.36E+15	5.59E+15	5.59E+14	4.61E+15	9.48E+14
Jiko Ceramic, charcoal fuel (Dry)	1.06E+16	1.18E+15	1.24E+16	1.61E+15	6.41E+15	1.92E+15
Jiko Ceramic, charcoal fuel (Wet)	7.91E+15	1.30E+15	1.11E+16	2.52E+15	5.00E+15	1.91E+15
Jiko Metal, charcoal fuel (Dry)	9.99E+15	1.47E+15	8.72E+15	1.04E+15	3.78E+15	1.17E+15
Jiko Metal, charcoal fuel (Wet)	5.73E+15	1.10E+15	8.41E+15	1.05E+15	1.74E+15	4.39E+14
KCJ Standard, charcoal fuel (Dry)	6.23E+15	6.43E+14	7.49E+15	1.33E+15	3.18E+15	5.53E+14
KCJ Standard, charcoal fuel (Wet)	7.01E+15	1.31E+15	7.15E+15	1.33E+15	2.99E+15	8.06E+14
Kenya Uhai, charcoal fuel (Dry)	9.27E+15	3.05E+15	1.07E+16	1.01E+15	6.10E+15	7.63E+14
Kenya Uhai, charcoal fuel (Wet)	1.07E+16	1.91E+15	1.06E+16	1.47E+15	4.47E+15	1.71E+15
StoveTec Charcoal, charcoal fuel (Dry)	8.42E+15	1.06E+15	6.41E+15	1.10E+15	4.56E+15	1.64E+15
StoveTec Charcoal, charcoal fuel (Wet)	7.02E+15	1.14E+15	5.99E+15	1.14E+15	4.94E+15	9.27E+14

**Figure S66. Ultrafine Particle Emission per Fuel Mass (Equivalent Dry Basis)
- Other Fuels**



	Cold Start		Hot Start		Simmer	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Belonio, rice hull fuel (Dry)	6.16E+15	1.58E+15	6.70E+15	5.52E+14	6.27E+15	2.80E+15
Belonio, rice hull fuel (Wet)	6.63E+15	5.72E+14	8.69E+15	3.06E+15	6.48E+15	1.27E+15
Mayon Turbo, rice hull fuel (Dry)	6.44E+15	3.90E+14	6.31E+15	7.50E+14	7.64E+15	7.88E+14
Mayon Turbo, rice hull fuel (Wet)	7.53E+15	3.65E+14	6.96E+15	3.22E+14	8.87E+15	2.22E+15
Oorja stove, Oorja pellet fuel (Dry)	1.56E+16	1.08E+16	9.92E+15	3.67E+15	1.20E+16	3.37E+15
Oorja stove, Oorja pellet fuel (Wet)	1.96E+16	7.20E+15	1.12E+16	7.19E+15	1.17E+16	6.47E+15
StoveTec TLUD, wood pellet fuel (Dry)	2.90E+15	4.26E+14	1.41E+15	4.79E+14	3.78E+15	9.83E+14
Jinqilin CKQ-80I, corn cob fuel (Dry)	2.73E+15	3.63E+14	3.18E+15	8.64E+14	2.65E+15	3.05E+14
Jinqilin CKQ-80I, corn cob fuel (Wet)	2.41E+15	7.34E+14	2.97E+15	5.82E+14	3.28E+15	6.37E+13
Protos, plant oil fuel	9.52E+15	4.13E+15	1.07E+16	3.06E+15	3.26E+15	4.69E+14

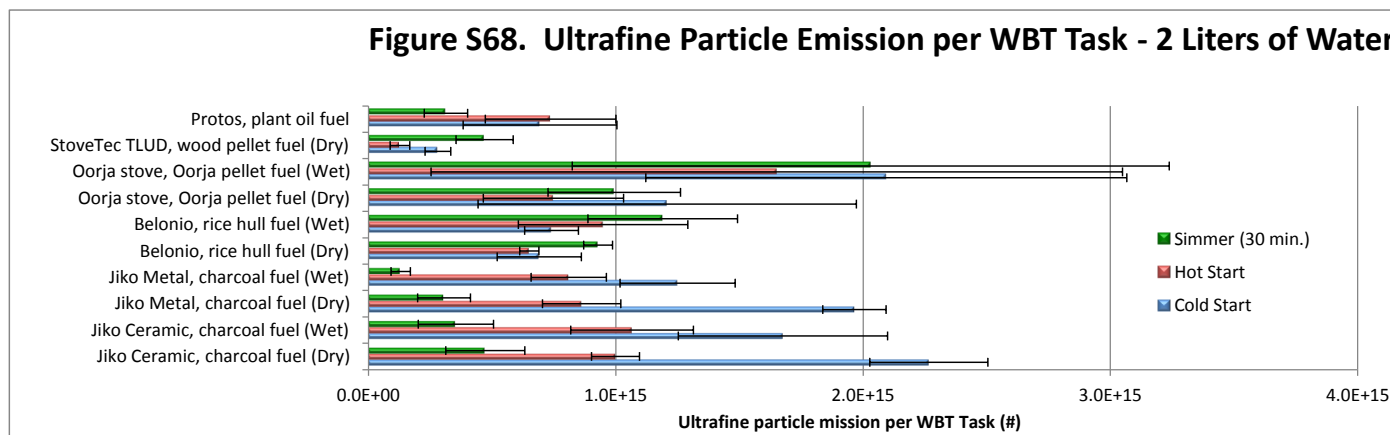
Figure S67. Ultrafine Particle Emission per WBT Task - 5 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
3 Stone carefully tended, wood fuel (Dry)	4.45E+15	9.68E+14	3.15E+15	1.01E+15	3.91E+15	1.06E+15
3 Stone carefully tended, wood fuel (Wet)	1.12E+16	1.05E+15	9.41E+15	4.26E+14	5.38E+15	4.48E+14
3 Stone minimally tended, wood fuel (Dry)	5.53E+15	6.07E+14	4.55E+15	1.95E+14	4.13E+15	3.05E+14
Berkeley Darfur, wood fuel (Dry)	1.88E+15	1.84E+14	1.49E+15	2.43E+14	1.47E+15	1.88E+14
Berkeley Darfur, wood fuel (Wet)	3.01E+15	4.21E+14	2.77E+15	3.49E+14	2.22E+15	1.09E+14
Envirofit G-3300, wood fuel (Dry)	8.56E+14	3.29E+14	5.82E+14	2.82E+14	1.10E+15	1.73E+14
Envirofit G-3300, wood fuel (Wet)	2.10E+15	1.86E+14	1.47E+15	2.16E+14	1.88E+15	2.92E+14
Envirofit G-3300, med. pwr., wood fuel (Dry)	1.15E+15	3.78E+14	7.80E+14	1.46E+14	1.11E+15	6.44E+13
Onil, wood fuel (Dry)	2.00E+15	2.84E+14	1.23E+15	2.14E+14	2.03E+15	4.87E+14
Philips HD4012 fan, wood fuel (Dry)	1.79E+15	1.62E+14	1.29E+15	3.96E+14	1.10E+15	8.96E+13
Philips HD4012 fan, wood fuel (Wet)	2.70E+15	4.13E+14	1.95E+15	2.64E+14	1.32E+15	2.12E+14
Philips HD4008 Natural Draft, wood fuel (Dry)	1.82E+15	1.77E+14	1.85E+15	4.69E+14	1.00E+15	1.91E+14
Philips HD4008 Natural Draft, wood fuel (Wet)	2.43E+15	2.01E+14	2.36E+15	1.88E+14	1.55E+15	3.17E+14
Sampada, wood fuel (Dry)	1.70E+15	1.73E+14	1.56E+15	4.41E+14	9.61E+14	2.93E+14
Sampada, wood fuel (Wet)	2.16E+15	1.25E+14	1.91E+15	2.28E+14	1.90E+15	4.43E+14
StoveTec GreenFire, wood fuel (Dry)	1.50E+15	8.72E+13	1.23E+15	2.25E+14	2.97E+14	1.25E+14
StoveTec GreenFire, wood fuel (Wet)	1.51E+15	3.30E+14	1.35E+15	3.00E+14	3.28E+14	8.74E+13
StoveTec GreenFire, med. pwr., wood fuel (Dry)	1.18E+15	2.01E+14	8.33E+14	1.62E+14	1.36E+15	2.97E+14
Upesi Portable, wood fuel (Dry)	3.20E+15	3.10E+14	2.60E+15	3.67E+14	2.37E+15	3.98E+14
Upesi Portable, wood fuel (Wet)	7.72E+15	9.01E+14	6.58E+15	4.19E+14	4.19E+15	3.73E+14

GERES, charcoal fuel(Dry)	3.70E+15	4.07E+14	2.32E+15	6.77E+14	8.00E+14	1.55E+14
GERES, charcoal fuel (Wet)	3.23E+15	1.16E+14	2.30E+15	1.83E+14	7.03E+14	2.13E+14
Gyapa, charcoal fuel (Dry)	2.14E+15	3.86E+14	1.63E+15	3.54E+14	6.32E+14	2.09E+14
Gyapa, charcoal fuel (Wet)	2.04E+15	4.41E+14	1.26E+15	1.56E+14	5.15E+14	9.91E+13
KCJ Standard, charcoal fuel (Dry)	1.91E+15	1.04E+14	1.29E+15	1.69E+14	1.99E+14	4.12E+13
KCJ Standard, charcoal fuel (Wet)	2.24E+15	1.96E+14	1.55E+15	3.51E+14	1.93E+14	6.35E+13
Kenya Uhai, charcoal fuel (Dry)	2.45E+15	8.82E+14	2.22E+15	4.87E+13	4.88E+14	1.02E+14
Kenya Uhai, charcoal fuel (Wet)	3.51E+15	3.60E+14	2.32E+15	3.41E+14	3.31E+14	1.44E+14
StoveTec Charcoal, charcoal fuel (Dry)	1.14E+15	1.49E+14	1.02E+15	3.23E+14	1.55E+15	1.50E+14
StoveTec Charcoal, charcoal fuel (Wet)	2.53E+15	2.29E+14	1.28E+15	4.45E+14	1.82E+15	2.75E+14
Mayon Turbo, rice hull fuel (Dry)	4.96E+15	5.26E+14	4.61E+15	2.24E+14	3.22E+15	2.22E+14
Mayon Turbo, rice hull fuel (Wet)	5.20E+15	3.63E+14	4.98E+15	1.33E+14	3.71E+15	5.50E+14
Jinqilin CKQ-80I, corn cob fuel (Dry)	3.10E+15	7.27E+14	2.08E+15	4.93E+14	2.24E+15	2.89E+14
Jinqilin CKQ-80I, corn cob fuel (Wet)	3.22E+15	9.06E+14	2.23E+15	2.14E+14	2.98E+15	6.21E+14

Figure S68. Ultrafine Particle Emission per WBT Task - 2 Liters of Water



	Cold Start		Hot Start		Simmer (30 min.)	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Jiko Ceramic, charcoal fuel (Dry)	2.27E+15	2.39E+14	9.99E+14	9.70E+13	4.73E+14	1.60E+14
Jiko Ceramic, charcoal fuel (Wet)	1.68E+15	4.23E+14	1.07E+15	2.48E+14	3.54E+14	1.52E+14
Jiko Metal, charcoal fuel (Dry)	1.97E+15	1.28E+14	8.62E+14	1.58E+14	3.06E+14	1.07E+14
Jiko Metal, charcoal fuel (Wet)	1.25E+15	2.33E+14	8.10E+14	1.52E+14	1.30E+14	3.91E+13
Belonio, rice hull fuel (Dry)	6.91E+14	1.70E+14	6.51E+14	3.88E+13	9.29E+14	5.84E+13
Belonio, rice hull fuel (Wet)	7.40E+14	1.09E+14	9.49E+14	3.43E+14	1.19E+15	3.02E+14
Oorja stove, Oorja pellet fuel (Dry)	1.21E+15	7.65E+14	7.48E+14	2.84E+14	9.94E+14	2.68E+14
Oorja stove, Oorja pellet fuel (Wet)	2.09E+15	9.73E+14	1.65E+15	1.40E+15	2.03E+15	1.21E+15
StoveTec TLUD, wood pellet fuel (Dry)	2.81E+14	5.20E+13	1.27E+14	3.97E+13	4.70E+14	1.16E+14
Protos, plant oil fuel	6.94E+14	3.11E+14	7.37E+14	2.64E+14	3.13E+14	8.78E+13